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New Chemical Products in the Textile Industry

Properties of Diethylene Glycol—Tendency of Chlorinated Hydrocarbons to Hydrolize in Solution—Points Pro and Con of Other Products—Formation of Emulsions—Triethanolamine as a Penetrant

By N. D. HARVEY, Jr. and E. W. REID

DURING the past few years a number of new chemical products have appeared on the market. These products have somewhat new and novel properties which are of special interest to the textile industry. In a few cases they displace the materials now used but on the whole are applied to new processes or as improvements in existing methods. The use of these products offer slightly different problems for each mill, but are easily adapted to meet specific requirements for the individual application.

The ethers of ethylene glycol are among the more recent type of chemicals to be used in the textile industry as they are of special value in certain dye baths. The monoethyl ether of ethylene glycol (Cellosolve) $CH_2OHCH_2OC_2H_5$, and the methyl and butyl derivatives are excellent solvents for certain dyes, especially those of the "Indigosol" type. The proper addition of these solvents to printing pastes results in shades of superior brightness and depth, especially when used on tin-weighted silk where excellent penetration of the dye is obtained. The excellent solvent property of these products is also manifested in the removal of albumin stains. Being soluble in naphtha and having the ability to hold certain amounts of water in solution they are finding an important use in the dry-cleaning industry.

The solvent power of Cellosolve may be utilized in the scouring and depainting of raw wool by the extraction system. Under normal conditions approximately one hour is required for this operation, where intimate contact between the solvent and wool is maintained with some agitation or movement of the solvent through the wool. The dirt and inorganic matter may be filtered off and the dissolved grease and tar removed by distillation of the solvent which is used again. The amount of grease left in the wool may be controlled by the time and temperature of extraction. In some mills it may be desirable to remove the last trace of grease with a dilute soap solution containing no excess alkali. Such a procedure is an economical scouring process and produces a softer and more lofty stock.

The ethers of diethylene glycol, such as the monoethyl ether of diethylene glycol (Carbitol) $CH_2OH.CH_2OCH_2CH_2OC_2H_5$, are similar in structure and properties to the ethers of ethylene glycol. Carbitol (Diethylene glycol monoethyl ether) is somewhat hygroscopic and is useful in textile finishing and as a coupling agent in the manufacture of soap and textile oils. At the present time it is being used as a dye solvent especially with the Indigo dyes. A small quantity of this solvent greatly increases the solubility of Indigo white, giving brighter and deeper shades of superior fastness to crocking. In the manufacture of denims the use of Carbitol with triethanolamine appears to produce about a 15% deeper shade than the usual dye methods. The quantity of each solvent for the maximum results must be determined for each individual plant and method used, but an example will serve as a guide.

Ten ounces of Indigo powder are pasted with 27 ounces of Carbitol and 14 ounces of triethanolamine and 100 gallons of sulphite liquor added. While the cost of the initial bath is probably somewhat above normal the action of the Carbitol is effective for several additions of the dye in maintaining the solution at the proper strength. The increased solubility of the dye in the presence of these solvents reduces the amount of hydrosulphite and caustic soda required and produces heavier, brighter and faster colors.

Carbitol is also used in basic printing, replacing in part or all of such materials as acetin, triacetin and glycerin. In general, Carbitol is a better solvent for dyes than the

usual materials and produces brighter and faster shades, although too much solvent gives the dye a greater affinity for the solution than for the fiber, resulting in lighter shades. By varying the amount of solvent used the shades may be controlled to a certain extent. In general, four to five times as much solvent as dyestuff gives excellent results, although this is controlled by the type of dye and the concentration of the dye solution.

Diethylene glycol, $CH_2OHCH_2OCH_2CH_2OH$, is somewhat similar to glycerin but is more readily soluble in water, less viscous and has unusual solvent properties. It is hydroscopic, non-corrosive and completely miscible with water. It offers a decided advantage as a lubricant for wool, worsted, cotton, rayon and silk. Its use in the mill to replace vegetable and mineral oil emulsions produces a stronger more uniform yarn of superior softness, odor, color and stretch. It is not an oil and does not become rancid or discolor the treated yarn on long storage. Being soluble in water the necessity of using an alkaline soap in scouring is eliminated, thus preserving the natural softness of the fibers and the original brightness of the colors as dyed. Since diethylene glycol is not gummy a large amount may be used where extreme softness and working qualities of the stock is desired. It penetrates the fiber, but does not impart an oily feel, however it renders the exterior scales very pliable. When the treated stock is carded the fibers pass freely without interlocking. This results in a more even yarn which is rounder and stronger due to the decrease in staple breaking and fly waste. An expensive feel is imparted to the finished fabric while the odor is sweeter than is obtainable with the highest grade of olive oil emulsions.

When used as a lubricant for raw cotton, more even carding, spinning and uniformity of twist, as well as increased poundage of yarn is obtained. Diethylene glycol is not sticky or gummy, and larger amounts may be used without fear of lapping around the rolls such as occurs with an excessive amount of an oil emulsion. A decided improvement in working qualities is evidenced by the use of more than the usual amount of lubricant due to the increased softness of the yarn. When a 50% diethylene glycol 50% water solution is applied at the finisher picker in the proportion of 1 pound for each 100 pounds of cotton, a noticeable decrease in card fly and droppings are evidenced and with the added weight of lubricant an increase poundage of yarn is obtained. The glycol is also a permanent conditioner maintaining a fairly constant moisture content in the yarn. It is also widely used as a softening agent and finishing material either in aqueous solution or with soaps and oils. When properly used it prevents knotting or curling of rayon yarns in knitting. As a throwing solution for pure silk, diethylene glycol offers several advantages over oil emulsions. It does not become rancid or discolor the yarn, and being completely soluble in water is easily removed. It is not necessary to scour before degumming while the presence of the glycol in the boil-off liquor is a material aid in dyeing where the silk gum solution is used. The diethylene glycol increases the solubility of the dye and gives increased penetration and more intense and faster colors.

Diethylene glycol is used to replace glycerin and alcohol for increasing the mutual miscibility of liquids, in emulsions, and as a coupling agent in soaps and textile oils with the advantage of increased softness of the yarn and also acting as a conditioner. It is used in the manufacture of sodium and potassium soaps (by the saponification of fatty acid glycerides) to decrease the reaction time and increase the solubility of the soap. For example, a mixture of

50 parts coconut oil,
25 parts 45% potash,
25 parts diethylene glycol

will be completely saponified if warmed for 15 minutes.

Diethylene glycol is also an excellent dye solvent, especially for basic and vat dyestuffs, both in dyeing and printing, giving markedly superior color value and brightness. A mixture of 80% diethylene glycol and 20% water is used in non-drying dye pastes to retain the desired plasticity and increase the solubility of the dyestuff.

The chlorinated hydrocarbons have not been used to an appreciable extent in the textile industry due to their tendency to hydrolyze in aqueous or alkaline solutions. The extreme stability of dichlor ethyl ether $(C_2H_4Cl)_2O$ and ethylene dichloride, $ClCH_2CH_2Cl$, permit these products to be used. They are excellent solvents for fats, waxes, greases and the like. Dichlor ethyl ether is a high boiling solvent (b. p. 174° C.) and is of value where high temperatures are necessary. It is being used in scouring for the removal of paint and tar brand marks from raw wool and grease and oil spots from cloth. It may be incorporated in fulling and scouring soaps, eliminating the necessity of hand spotting. As a general rule, 2% of dichlor ethyl ether (based on the weight of the soap stock) is satisfactory, although the exact amount will depend upon the condition of the wool or cloth to be treated. Excellent wetting-out agents and penetrants have been compounded by the use of varying amounts of dichlor ethyl ether with soaps and sulphonated oils, often with diethylene glycol as a coupling agent, although the latter is mainly used as a softening and conditioning ingredient. This use is especially applicable to cotton due to the solvent action of dichlor ethyl ether on the cotton waxes which permits the water to penetrate the fiber more readily. It is quite obvious that such a material should be of value, in kier boiling as a substitute for caustic alkalies to prevent harshening of the fibers, in peroxide bleaching to permit better penetration by desizing the goods and dissolving the natual pectin, and as an aid in mercerizing to eliminate wetting out or boiling out of the goods enabling the caustic solution to mercerize more rapidly and thoroughly. On account of its high boiling point it may be used in hot solutions, as in peroxide bleach, with negligible loss. This is of special

importance in the fulling and scouring of woolens and worsteds as the solvent remains in the goods throughout the process and removes the stains. When incorporating this solvent in soaps for scouring, spotting or fulling it is essential that the soap and solvent be thoroughly mixed previous to their addition to water. If the solvent is added directly to an aqueous soap solution an emulsion will not be obtained as the solvent will settle to the bottom of the vessel. When used with a sulphonated castol oil not over 30% of solvent (based on the weight of the oil) should be used, as the larger amounts cause the formation of a very thick cloudy paste. This paste may, however, be brought to a clear solution by the addition of Cellosolve or butyl Cellosolve giving a mixture which is an excellent spotting compound. This solvent has found application in the scouring of silk and rayon, as well as a general solvent in dry cleaning.

Ethylene dichloride may, in general, be used in the applications mentioned for dichlor ethyl ether. It is slightly more soluble in soap solutions and is a more rapid solvent for fats, waxes and greases. On account of its low boiling point (83° C.) this solvent cannot be used in hot solutions.

Triethanolamine $(C_2H_4OH)_3N$, being a substituted ammonia, resembles this material somewhat, but has none of the disadvantages of the latter. Being high boiling, it is not volatile, its alkalinity is about one-sixth that of ammonia, and it is a practically odorless, slightly viscous liquid.

Triethanolamine, as a base, is strong enough to form soaps with fatty acids, such as stearic, palmitic and oleic. This reaction takes place in molecular amounts almost instantaneously, and with oleic acid, without the addition of heat. Stearic acid, being solid, is melted and the coupling affected at that temperature.

Since the commercial grade of triethanolamine is a mixture of approximately:

75% triethanolamine
20-25% diethanolamine
0- 5% monoethanolamine

its molecular equivalent is taken as 133. The following proportions are used in preparing the oleate soap:

22 parts oleic acid
10 parts triethanolamine

The soap is formed by the simple process of adding the two ingredients and stirring, the coupling taking place with the generation of a slight amount of heat.

Applications for such a material immediately present themselves. The scouring of raw wool, fulling and scouring of wool and worsted cloth, and the boiling off of natural silk which has always been accompanied by the danger of fiber damage from the free caustic alkali liberated in the hydrolysis of soap solutions. To all intents and purposes, the water solutions of triethanolamine soaps are neutral, even with some excess base, since the latter is so much weaker than ammonia. These soaps are equal in all respects to sodium and potassium soaps, but far superior in being neutral and thus harmless to the finest of fabrics and fibers.

Triethanolamine is a strong emulsifying agent, excellent penetrant and wetting-out assistant and is soluble in gasoline, mineral oils, turpentine, chlorinated solvents, pine oil, and other similar materials.

In the formation of emulsions a few practical recommendations will be given to assist individual investigations. In the examples given, a procedure slightly different from the ordinary is followed. The required amount of acid is dissolved in the oil, and to this is added a small amount of water containing the necessary triethanolamine. It will be found that this method gives instantaneous emulsions which may be stocked as concentrated solutions and diluted as desired:

	Triethanolamine %	Oleic Acid %
Mineral Oil	3 to 4	8 to 10
Pine oil	2	5
Linseed oil	½	..
Kerosene oil	2	8
Cottonseed oil	1 to 4	6 to 30
Neatsfoot oil	2	14
Olive oil	2	10

In most cases, the above proportions, which are based on the total weight of oil plus the emulsifying components, when made into concentrated emulsions may be diluted by stirring water into them to form a cream and then continuing to add water until the desired concentration is obtained. In certain cases, if very dilute solutions are desired, the proportions should be altered slightly.

In preparing emulsions of paraffin or carnauba wax, triethanolamine stearate is preferable to the oleate. The procedure usually followed is to dissolve the stearic acid in the molten wax and this solution poured into water containing triethanolamine.

	Parts by weight
Paraffin wax	32
Stearic acid	3
Triethanolamine	1
Water	100
Carnauba wax	20
Stearic acid	2
Triethanolamine	1
Water	100

Paraffin oil may be substituted for paraffin wax in any desired proportion.

When triethanolamine or its soaps are used as a penetrant and wetting-out agent an excess of triethanolamine is recommended as the soap is more soluble in water as the troubles occurring from free fatty acid are entirely

eliminated, and the detergent powers greatly increased. The amount of free base should be at least 10%, with more as desired in individual cases. For these uses the oleate is preferable and has excellent wetting and softening action without the need of free fatty acid for better solubility. This soap, with 10% excess base, will hold in complete suspension up to 30% of its weight of dichlor ethyl ether, and up to 40% of ethylene dichloride, either of which may be diluted to any desired concentration. Such a mixture is excellent for softening tar and paint on raw wool, thus facilitating easy removal by the following operations of carbonizing and dusting. A small amount of Cellosolve has been found to have a pronounced solvent action also in this connection.

Being soluble in gasoline, and an excellent spot remover, triethanolamine soap has proved of real value to dry cleaners for all types of fabrics, being harmless to both material and color, but fully as effective as compounds at present in use, and in many cases far superior.

Cleaning and Protecting Lamé Fabrics

By FRED. GROVE-PALMER, A.I.C.

IN MANY countries, and from earliest times, metallic fabrics have been used for the clothing of princes and nobles. In those days the cloth was usually of gold; the "Field of the Cloth of Gold" is a name in European history; the rulers of Indian provinces garb themselves in cloth of gold. Coming to modern times, there is always a fashion for dresses in these fabrics which the Parisian costumers call "lamé," meaning yarn which is wound round with "lames," or thin, flat strips of metal.

There is a further limited use for lamé fabrics in the upholstery trade, but probably the greatest quantity is used in the making of fancy shoes and slippers. The most fashionable colors for these are gold and silver, the cloth being sometimes plain and at other times decorated and brocaded. The cost of silver being as low as it is, much of that metal is used in the production of lamé cloths, but when it comes to a consideration of the yellow metal the gold-diggers of Broadway and elsewhere suffer disappointment; the modern craze for change and cheapness will not stand for the high cost of the real metal, and consequently the gold is sophisticated to the point of extinction.

Because of this, though the lamé fabrics look very fine, they suffer from the disadvantage of tarnishing rapidly. If gold were used this would not happen, nor would it occur if silver-gilt were employed, as it has been often enough in the past. This cheapening alloy has been in vogue from very early times and was made by wrapping a bar of silver in a sheet of gold. This was heated in a furnace to a temperature high enough to start both metals fusing; it was then removed, and when cold-hammered out to the very fine ribbon which has every appearance of gold and behaves as such. This method of cheating wealthy employers is alluded to in some of the ancient Indian historical books. Gold is very rarely used at the present time for this purpose, and the semblance is obtained by the use of alloys of copper, which, like silver, soon begin to tarnish, and long before the shoes or dresses are done with the beauty of the fabric has faded.

This would not cause the manufacturers to be inconsolable, perhaps, as it is all good for trade; but when the tarnishing occurs to rolls of the unmade-up cloth lying on the fixtures in the stores, or even in the warehouses of the wholesale firms and in the factory itself, it is a different matter. The tarnish takes the form of brown stains of varying intensity, due to the formation of sulphides of the metals caused by the action of sulphur in the atmosphere arising from coal and coke fires. If both the air and the cloth were perfectly dry, the reaction would not occur; but there is always sufficient moisture present in both to permit the formation of the black sulphides which render the materials unsalable. It is therefore necessary so to treat it in order that all traces of the sulphides shall be removed without damage to the delicate yarn or any risk of staining the cloth backing.

A perfectly sure way of effecting a cure is to run the goods through a solution of sodium cyanide—a dilute solution is all that is required. Potassium cyanide is equally useful, but it is more expensive, though the difference in cost for just a small amount of work is practically negligible. If large quantities of cyanide are used in the mill, then it is cheaper and equally effective to buy the sodium salt.

It is hardly necessary to mention that this substance is a deadly poison; the rules and regulations governing its use in the mill will need to be very stringent. One has never known an accident arising from the use of cyanide in a textile factory, but that may be due, to some extent, to the fact that each individual worker has had it pointed out quite clearly that there is danger in handling the stuff and the cloth soaked in it until it has been properly washed so that all trace of the cyanide is rinsed right out. This precaution is taken every time, not merely once every so

often, so that there is no risk of having to express surprise at the inquest.

A solution containing from ½ to 1% is strong enough for most purposes, and it is used at a temperature of from 40 to 50° C. It may be run through a mangle with a light nip or over the winces in the ordinary way, passing from the cyanide bath right into the rinsing water, which should be frequently changed. A few minutes in warm water will suffice to wash out the last traces and the goods may then be sent to be dried up. It is advisable always to do this in a room with doors and windows closed so that there may be no opportunity for sulphur fumes from boiler fires and other possible sources to contaminate the lamé threads again.

If it is a question only of cleaning up silver cloth, it is much safer and almost as effective to use ammonia, but this cannot be brought into play for the copper alloys of "gold" fabrics. In dissolving away the sulphide of silver, ammonia forms almost colorless bodies, but in the case of copper the resulting compounds are of a deep blue, which not only stains the cloth backing but produces a messy-looking shade on the metal; it has to be specially treated to get rid of it. The strength of solution found most useful for clearing silver is of the order of 1 pint to 10 gallons of water in which there has been previously dissolved 1% of neutral oil soap. Sometimes badly stained pieces or those in which the blemish is of long standing will prove a little obstinate and call for an increased quantity of ammonia. The temperature of the bath and the method of working are as already described under the cyanide treatment.

Sodium hyposulphite (thiosulphate) has been recommended for the alloys of copper as an alternative to the very poisonous cyanide bath; a solution containing 1 or 2% will generally be found strong enough and if well washed does not seem to give rise to any subsequent trouble. Another remedy that has been tried with success is dilute solution of salt of sorrel or lemon, potassium binoxalate. Here again we are dealing with a dangerous chemical, and the same care and precaution should be exercised as are needed in the case of the cyanide, which, though quicker, is hardly less dangerous.

Curing a disease is useful, admittedly, but it is far more satisfactory to prevent the occurrence of the malady; this is very much the case with lamé fabrics, which can be so treated that there is very little risk of their becoming tarnished under any of the circumstances to which allusion has here been made. Such treatment is not very troublesome, nor is it unduly expensive when consideration is given to the fact that the protection is practically permanent.

The process consists in coating the face of the lamé fabric with a solution of cellulose nitrate of such constitution that it will flow evenly into the interstices of the cloth, effectively but invisibly covering the metal with a thin though impenetrable layer of "cellulose." Many mills already use spray guns for some of the processes, and in this case nothing more is needed except a drying hood, fitted with an outward draft fan, and a means of passing the goods upward in front of the gun operator. For large quantities of material it would, of course, be better to have a spraying device fixed in front of the machine whereby the supply of "dope" could be automatically conveyed to the cloth.

The drying hood may be of any convenient design and should be warmed by steam pipes; naked gas flames could not, of course, be used, because of the inflammable nature of the cellulose nitrate solvents. By keeping the amount of solution sprayed on as low as possible, it is not necessary to have a very long hood, as the volatility of the solvents permits of the rapid drying of the cloth. It is well to introduce a gear for altering the rate of passing to suit varying circumstances.

Manufacturers of cellulose lacquers will be able to supply a grade suitable for this purpose if they get to know just what is expected of it; with this they will send a solution for thinning down as required, and another for cleaning the gun and other apparatus when the work of the shift is finished. It is well to remind users not to replace the thinnings with cleaning solution just because it is cheaper; it generally leads to the production of a very bad surface on the cloth. This is caused by the precipitation of the cellulose nitrate in a powdery form entirely differing from the transparent film at which the operation is aiming. This blinding will ruin the appearance of the material altogether and take away all the luster. If such a mistake should occur, it may be remedied by repassing the batch over the spraying perch and treating it with the thinning solution alone. After that it will require another light spraying with the clear lacquer so that the cellulose may be spread evenly all over the metal.

Some users prefer to make their own solution, relying on the laboratory for the supply of a suitable liquid. here is not much difficulty about this so long as a few simple precautions are observed. The formula given below is one which has always given good results, and it can be modified slightly, making it either stronger or weaker, as the stiffness or otherwise of the material may demand. The recipe is:

Cellulose nitrate, damped with 30% denatured alcohol, as received	1 pound
Tricresyl phosphate	1 fl. oz.
Butyl acetate	1¼ pints
Acetone	4½ pints
Camphor	2½ ounces
Castor oil	2½ fl. oz.
Benzol	4½ pints

The tricresyl phosphate and butyl acetate are poured onto the nitro-cotton and well stirred in, then the acetone goes in, being also thoroughly stirred. The cotton rapidly dissolves; meanwhile the camphor and castor oil are added and mixing continued. When the solution is complete and there are no signs of undissolved nitrate, the benzol may be poured in, a little at a time, continuing the agitation. The whole is then stored in a well-stoppered holder for a few days—a week is better—so that it may ripen. This ripening of cellulose nitrate solutions is a matter which is not very well understood, but there is no doubt about it being a great improvement. Only the best grade of nitro-cotton should be purchased for this purpose and it should be of low viscosity. Cheaper qualities sometimes yield a solution that has straw color, which might easily detract from the luster of silver lamé, even though it did not materially affect the near-gold varieties. There are many different kinds of "plasticizers" that might be used instead of tricresyl phosphate; the majority of them are just as good. This one is given because it is not expensive, it keeps well and has always yielded good results.

It will be found that a spray based upon the formula just described will have no apparent effect upon the hand of the cloth; actually it is a very little stiffer, but the difference is too slight to be noticed very easily. If it is required to be a degree or two stiffer, the tricresyl phosphate and also the castor oil may be either or both reduced in quantity or entirely omitted, depending upon the amount of additional firmness that is asked for.

The thinnings used for this solution are just the solvents over again: Butyl acetate, 1 part; acetone, 4 parts, and benzol, 4 parts.

The cleaning liquid may be made on the following line: Acetone, 1 part, and benzol, 4 parts.

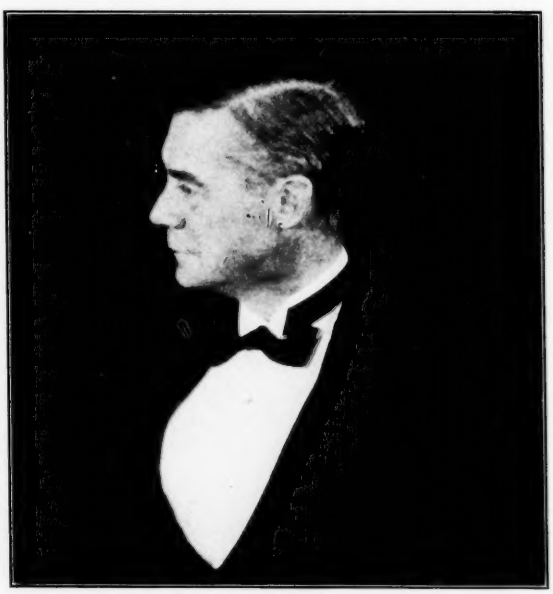
When the fabric has been sprayed and dried, it will be found that all traces of odor have disappeared and the material can be made ready for dispatch or storage. In some cases it is sent out with an interlining paper to protect the surface of the metal; when this is done, it is very requisite that only a pure quality paper should be used, as some grades have the effect of producing stains almost as badly as impure air arising from the fumes of gas lamps. Naturally, the manufacturer of lamé cloths who is exercising the precaution of interleaving his product with paper will be aware of the danger that may occur and will have chosen a suitable paper. The allusion is here made to the need of keeping a sharp look-out that this quality does not vary for some reason such as the wrong quality being sent in by the supplier or issued by the storekeeper. Some bad cases of tarnish have resulted from this cause.

The advent of rayon, with its exceedingly high luster, has seen the introduction of fabrics that resemble the metal tissues very closely so far as appearance goes, and have not the disadvantage of tarnishing. Although they have not the same durability they can be cleaned more easily, and in many cases of decorative work it has been found that the rayon fabrics answer at least as well as, if not better than, the lamé cloths. At the same time, for richness and beauty in special circumstances there is nothing to come within reach of real cloth of gold, and the fact that many museums possess ancient specimens of the fabric proves the great advantage of using the best materials for the best purposes.

The Evening Textile School, 124 West Thirtieth Street, is offering a course in textile chemistry. The course includes the following topics: Identification of the common textile fibers as cotton, wool, silk, linen and rayon and distinguishing the different types of rayon; special treatments applied to the above fibers, including mercerization of cotton and test for same. It also includes scouring and bleaching of the common fibers and the effect of chemicals on the fibers, finishing of cotton goods, etc.

The class will meet Tuesday and Thursday evenings from 7 to 9 and will start February 4.

T. T. Lucas, graduate of the Textile School of North Carolina State College, has recently been elected president of the Pinehurst Silk Mills, Hemp, N. C. Mr. Lucas was formerly connected with Wellington, Sears & Co., New York, having entered that organization just after graduating from the Textile School.



A Recent Likeness of the Late Dr. Berthold Wuth

Proceedings of the American Association of Textile Chemists and Colorists

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NOVEMBER MEETING OF RHODE ISLAND SECTION

The Manufacture of Starch, Dextrine and British Gum, and Its Application

By HARRY A. CROWN
Corn Products Refining Company

IT is a pleasure to me to come to you to tell you something about our industry. When I was asked to come to talk to you, I felt something like the preacher, a colored preacher, about whom I recently read. A friend whom he hadn't seen for some time met him and said: "Where you-all preachin' now, brother?" He said: "Nowhere." The other said: "That's too bad; a fine preacher like you, too." The preacher said: "That is just it. I am a preachin' preacher, not a prayin' preacher, and the last congregation I had wanted a prayin' preacher."

I am afraid I am somewhat like the preacher. He said that was out of his line. Talk is out of my line. I am just a working chemist.

The interest and wonder of visitors, chemists as well as laymen, to our plants always impressed me and indicated that our industry must have some unusual features. Could you make a personal tour of our plants, I know you would be amazed at the skill and efficiency used in separating corn into its various components and at the number of commercial products made from them. Since this is not possible tonight, I shall attempt, through description and some exhibits, to "bring the plant to you," and shall try to help you visualize the various operations.

The corn products industry has many ramifications, all based on the fundamental process of first separating the kernel of corn into its various components. Let us, then, briefly consider the corn kernel. We find it has a covering of cellulose, called "hulls," the endosperm or bulk of the kernel, which contains starch and gluten, and the germ or embryo, containing the oil. In addition, there are mineral salts and pentosans distributed in the kernel. Naturally, the composition of corn is subject to some variation, depending on conditions of breeding and cultivation, but the following may be considered as an average analysis of the dry substance:

Starch	60.0—65.0%
Oil	3.0— 4.5%
Ash	1.2— 1.3%
Pentosans	7.0— 7.5%
Protein	8.0—10.0%
Fiber	1.2— 1.5%

The moisture content ranges, according to the season, from 11 to 20%.

The corn as received at our plants is off the cob and is termed "shelled corn." I haven't a sample, but here is some that has been steeped. As it is unloaded at our grain elevator it is cleaned to remove all particles of cob, corn dust, dirt or any foreign matter that may be present. This is effected by the use of blowers and sieves, and electromagnets are used to remove any pieces of iron or nails. The cleaned corn is either stored in large concrete tanks or silos as a reserve stock, or is sent direct to the "steeps." These are large cylindrical tanks with hopper bottoms and with a capacity of 2,600 bushels each. The corn is completely covered with water containing 0.25 to 0.30% SO_2 and is steeped for thirty to forty hours, until the kernels have become softened. Here is a sample of the steeped corn. If you come up later to examine it you will notice it is swelled considerably; if you had some of the original corn you would notice the amount of swelling. The SO_2 aids in softening and prevents fermentation of the corn. The water is kept in circulation and the temperature maintained at 115 and 125° F. This steeping is an important operation, and great care is taken to have the temperature sufficiently high to effect a rapid softening of the corn without in any way affecting or weakening the starch granules. The steep water dissolves the salts, soluble carbo-hydrates and soluble protein, and when the gravity reaches 5° Bé. the liquor is drawn off and evaporated to 18° Bé. Here is a sample of the steeped water. You will note the color of it. After this has been concentrated to 18° it is sent to the feed house. An average analysis of the dry substance in a 5° liquor is:

Ash	20.00%
Protein	38.00%
Organic (not protein)	49.00%
pH value	4.00%
SO_2 free	0.03%

The softened corn receives a final wash with fresh water and then passes to the attrition mills. These consist of two close-set plates with projecting blunt teeth, revolving in opposite directions, which do not grind the kernel but simply crack or tear it to loosen the germ, without breaking it.

The next operation is the separation of the germ, which is done in a rather novel way. The cracked corn is mixed with water and run into short, deep tanks called "germ separators," equipped with a spiral agitator at the bottom and a slow-moving paddle on top. The germ, due to its oil content, rises to the surface and is skimmed off by the paddle, while the endosperm and hulls settle to some extent and are drawn off at the bottom for further treatment. The germ is washed free from any possible adhering starch and hulls in a series of reels, and is then pressed in squeezers to remove as much water as possible before drying in large rotary steam dryers. The dry germ, containing over 50% oil, is sent to the expellers, where, under pressure and heat, the oil is squeezed out.

Here is the germ after it has been dried, and here is a sample of the oil. The residue, or oil cake meal, still contains about 10% of oil and is used in preparing cattle feed. The oil from the expellers is filter-pressed to remove any fine particles of germ fiber which it may contain, and then allowed to cool and settle in large tanks. Then the clear oil is drawn off and sent to the oil refinery for final purification. After removing the fatty acids and passing through refrigeration machines, clarifiers, filters and sterilizers, the light golden-yellow oil called "Mazola" is obtained. As we get it from the germ it is cloudy and has to be clarified.

The next step in the process is the separation in reels of the coarse hull or skin of the corn from the gluten, starch and some particles of fine hull which still adhere to the starch and gluten. I refer to the diagram. We have the endosperm. We have to separate them. The coarse hulls which do not pass through the screens on the sides of the reels are sent to the gluten feed department, where the greater part of the water is pressed out in squeezers before the hulls are dried in large rotary dryers.

Here is a sample of the hulls. You will see they don't show any starch. They have been completely freed from starch and gluten. The mixture of starch, gluten and fine slop is sent to the buhr mills, two large stones, one revolving over the other. The grinding in this mill completely separates all particles of hull from the starch and gluten. This finely ground mixture is then passed over shakers, which are vibrating frames covered with panels of fine mesh silk. The starch and gluten pass through the silk and the fine pieces of hull remain on the screen. These are collected as a slop which is filter-pressed to remove excess water, and are then added to the coarse hulls.

The mixture of starch and gluten which passed through the silk shakers, mixed with water to 6 to 7°

Bé., is sent to the table house, where it is run over long, slightly inclined wooden tables. These are really troughs about 120 feet long, 2 feet wide and 9 or 10 inches high. The lower end of the table is left open and is 3 or 4 inches lower than the upper end or head. The liquor is run in a continuous but gently flowing stream on to the head of the tables. The starch, having a higher specific gravity, settles and deposits on the tables, while the gluten flows on with the water and is collected in large tanks called "settlers." We have here [holding up jar] gluten liquor which is run over the tables, and here is a sample of the starch as it settles on the tables. This effects a complete separation—practically complete—of the starch from the gluten and any fine membranes. In this state there may be a trace of glute and some soluble material, which we will consider later. This gluten liquor is allowed to stand until the gluten and water are partly separated, the supernatant water drawn off and the thickened gluten pumped to the filter press, after which the pressed gluten, freed from as much water as possible, is mixed with the hulls and concentrated steep-water, and dried to make gluten feed, enough oil cake meal being added to give the proper oil content. Here is the final feed, which consists of this gluten, some of this ground oil cake, and hulls. This produces a nutritious stock feed with the necessary food elements, protein, fat, mineral salts and fiber. It is sold under a guaranteed analysis that the protein should run not less than 23%, fat not less than 2% and fiber a maximum of 8.5%. Gluten is also dried without the addition of hulls and steep-water to make corn gluten meal, which has over 40% protein and is also used as stock feed.

The corn kernel has now been separated into its various parts, as follows: First, steep-water, containing the solubles; second, the hull or skin; third, the germ which contains the oil; fourth, gluten, the part of the endosperm containing the protein; and, fifth, starch, the main product, which constitutes about 65% of the grain, and after further treatment, depending on the products desired, is made into the various edible and commercial starches, corn syrup, corn sugar, dextrine and British gum.

We now have the starch on the tables, separated from the other components of the corn. Formerly it was removed from the tables with shovels and dried in the kilns without further treatment. Now it is flushed off with large streams of fresh water, which again puts the starch in suspension. It can then be deposited again on the tables or filtered in continuous rotary filters and washed. Either treatment reduces the solubles, or traces of gluten which might adhere to the starch.

Starch when marketed as such is removed from the filters and conveyed to the drying kilns. These are long, narrow passages or tunnels in which the wagons holding the starch are slowly moved through a current of hot air traveling in the opposite direction. The wagons, holding 2,000 pounds of starch, are composed of screened sections which keep the starch separated and allow the free circulation of air. It takes these wagons about twenty-four hours to pass through the kilns to produce dry starch. The wagons of starch are automatically emptied in the starch tipple by turning over several times while securely clamped, the starch falling into a conveyor from which it is delivered to reels before passing to the milling process. This is called "pearl starch," which looks like a powder but has a mixture of various sized crystals in it. The rate of drying governs the resulting form of the starch. Pearl starch is obtained by a relatively rapid drying and crystal starch by a slow drying, lasting a week or two. Sometimes we get crystals 3 or 4 inches long. They would break up anyway. I might say it is a physical characteristic—it does not alter the nature or paste of the starch which would be formed by cooking them up. In making the crystal starch, the wet starch is formed into a compact cube which, when dry, breaks up into the so-called "crystals" with irregular form. The lower the temperature the larger the crystals. Powdered starch is obtained from pearl starch by a grinding and bolting operation, and contains 2% less moisture. Food starches are purified by retabling or washing to meet the requirements of the pure food laws.

Starch as obtained above in the separation of the corn is what we term "thick boiling starch." Thin boiling starch is made from this starch by treatment with dilute acid, usually sulphuric, at a definite temperature and concentration until the desired modification is obtained. The time of conversion varies from twelve to twenty-five hours, depending upon the particular modification desired. Naturally, the longer the conversion the more fluid or more thin-boiling the starch becomes. After the completion of the conversion the acid is neutralized, the starch separated and dried in the usual manner to form either pearl or crystal starches. Thus are made what we call Eagle finishing starches, which range from low to high fluidity.

Dextrine and British gum are made from powdered starch previously described. This is acidified with dilute mineral acids, usually hydrochloric or nitric, in the manufacture of dextrine and heated in the "cookers." These are cast-iron kettles provided with a stirrer and heated with a steam jacket or otherwise. Some plants use oil; the other methods were direct fire in a rotary kiln, but ours are high-pressure steam. The

amount of starch converted into water-soluble dextrine or the degree of conversion, the color of the product and the pasting properties depend upon the time and temperature of conversion, the amount of moisture and the kind and amount of acid used. British gum is made by heating or roasting the powdered starch without the addition of any acid, the essential factors being temperature and time. You will readily realize what a variety of dextrines and British gums can be made by varying any of these factors. The acid used in making dextrine is a catalytic agent only, and during the roasting most of it volatilizes.

While chemistry and chemical control are used wherever possible in our processes, a direct application of chemistry is in the manufacture of corn syrup, sometimes called "glucose," and corn sugar. The reaction is that of hydrolyzation, effected by the use of the catalyst, hydrochloric acid.

The washed starch from the filters, diluted with water to 22° Bé., is sent to the refinery, where it is treated under pressure and heat in closed bronze converters by the addition of steam and a small amount of C. P., hydrochloric acid. Each converter holds about 2,200 gallons of starch. The time required for a sugar conversion is approximately thirty-five minutes at 45 pounds steam pressure; and for a conversion of corn syrup the time is twenty-two minutes at 30 pounds pressure. During the conversion the starch is converted into dextrose, the amount depending on the various conditions. Liken starch to the car at the top of a hill. You can start it down and apply the brakes at any point you desire—if you check it there you form thin boiling starch; if you come farther down and check it, you form corn syrup; or you can let it go the whole way and carry the reaction to completion and form sugar. We also have that sugar in pure form, known as "cerelose."

Starch
- Thin boiling starch
- Corn syrup (dextrine, dextrose & maltose)
- Sugar (Cerelose)

The acid is increased. That is done because we have to carry the acid to completion.

After the starch has been converted into dextrose, the acid is neutralized with sodium carbonate. The liquor is filtered in centrifugal machines, filter presses, and then passed through bone char filters to remove all unconverted substances, which may be particles of starch, gluten or any other parts of the corn that have been mechanically carried along with the starch. The clear liquor is evaporated in vacuum pans to 30° Bé. and again filtered through bone char to clarify and removed the dissolved coloring matter and the finest particles of foreign matter which may have passed through the first filters. Here are some of them after they have been converted. You see, they have developed some color in the bone char filter, which removes the color, as you will see in some of these other samples. The resulting liquor is a clear, colorless, syrupy liquid of a sweet and pleasing flavor. This is concentrated in vacuum pans until it is 40 to 45° Bé., which is the finished corn syrup unmixed, as used in candy making, baking, preserving and canning of fruits, as well as in the manufacture of Karo.

The various grades of corn syrup which are converted to a higher dextrose content than the corn syrup are purified and concentrated in the same way as corn syrup. For 70 and 80 sugar—i. e., corn sugar containing 70% and 80% reducing sugars—the liquor is run onto the large tables, where it is allowed to cool and crystallize, or solidify. When completely cooled, the large cakes of sugar are cut into slabs and conveyed to the chipping machine, where they are cut into small pieces before packing. Here is a sample of chip sugar.

Cerelose is 99.5 to 99.85% pure dextrose, and is made by allowing the dextrose to crystallize from the high converted sugar liquor. The sugar is slowly agitated during crystallization, which requires from 90 to 100 hours, after which it is separated from the uncrystallized liquor in centrifugals. While still in the centrifugal basket it is washed with pure water until nothing remains but the crystallized dextrose, which is then delivered to hot air rotary dryers, where the excess of moisture is removed before screening and packing in bags for shipment. Pure dextrose has become a commercial product and its consumption is increasing all the time.

Pure dextrose was prepared a long time ago, but remained practically a chemical curiosity until a few years ago. About 1811 Kirchoff discovered that from the commercial standpoint dextrose, in glucose, could be produced more advantageously from starch by processes practically identical with those carried out in the human body, when starch is digested and prepared for assimilation by being transformed into dextrose. Starch thus became the accepted crude material. Cornstarch has been selected on account of the plentiful supply of corn and because of the high starch content of the grain. Hence the names "corn syrup" and "corn sugar."

Until a few years ago the commercial products did not extend beyond liquid form, as corn syrup and the grades of sugar mentioned above. The cost of purification and crystallization of the refined product remained for a long time prohibitive for large-scale commercial production. This problem of purification and

crystallization was solved economically by my former chief, C. E. G. Porst, and W. B. Newkirk, of the Corn Products Refining Company, and pure crystallized dextrose became a commercial product.

We will now consider the applications. The industrial applications of our products are numerous and varied. As your interests lie, no doubt, chiefly in textiles, I shall consider this field first. In the cotton industry, cornstarch is used very extensively in the slashers for warp-sizing, especially as it does not break down under the continuous boiling maintained in the size-box. It is used to lay down the fuzz and to increase the strength of the yarn for better weaving. Formerly pearl or thick boiling starch was used for this work, but modified starches, called our Eagle finishing starches of 20 and 40 fluidity, are increasing in use, and sometimes a small amount of a high converted gum—like our No. 228—is added to regular pearl starch. It acts as a binder and also gives penetration into the yarn. If you will refer to "Cotton," issue of May, 1921, you will find an article, "A Review of a Report on Sizing," in which it is shown that Eagle thin-boiling starch increased the breaking strength of the yarn considerably. The per cent break increases was as follows:

Pearl starch	9.90%
Famous "X" (thick boiling)	13.93%
Eagle	19.70%

In textile finishing, thick and thin boiling starches are used, as well as white and canary dextrine. In the finishing of khakies, a high converted British gum has been found to give excellent results. The finished goods do not show a streak when scratched.

At the present time the consumption of British gums in textile printing is running high. Several types of gum are being used, and this probably depends on plant equipment and manipulation. Some use low soluble and others high soluble gums. Perhaps a word of explanation regarding these terms is advisable. We speak of gums and dextrose as being of high solubility or low. We mean this: The solubility is determined in this way: Two grams are mixed with water at room temperature and allowed to stand for an hour, with frequent shaking. The water has previously been made up to the 200-c.c. mark. At the end of the hour the clear solution is filtered and 100 c.c. is evaporated to dryness. The percentage obtained that way is expressed as the soluble. The moisture has previously been determined and the soluble is expressed on the dry basis. That does not refer to the solubility of gum and dextrine in hot water. The higher the conversion of the gum the greater will be the per cent thus soluble. Therefore, we know that a gum with a high per cent of soluble will require less water than one with a low per cent when cooked to form pastes having the same body or viscosity, and the concentration of the former will be greater than that of the latter. In selecting gums for printing, one must consider several requirements: sharp definition—i. e., the colors must not run; the paste must be smooth and scrape off the rolls evenly; it must not clog up the doctor-blade, and in some cases it must wash out freely and in others more slowly; and the amount of dry substance in the paste is important as affecting the yield value of the dyes. It is therefore necessary to select gums within certain limits to meet these requirements. Of these, the gums with lower soluble will form thicker pastes, less can be used for a given plasticity with a resulting lower concentration, and will ordinarily give a higher yield value to the dye and will not wash out so readily in the open soapers.

In recent years we have developed another product called "amijel." It will have some uses in this connection. It is a gelatinous starch. It has been treated to mix with cold water to form a paste which has a body, or greater body than can be obtained by cooking starch. It has occurred to me that it can be used in connection with printing gums, in this way: if paste has been formed that hasn't the desired body, it can be thickened up by adding some of the amijel, which will absorb the water and form a stiff paste. The degree of thickness will be governed by the amount of this added.

Another branch of textiles which uses starches, gums and dextrines is the carpet mill industry. Its requirements are different from those of the cotton textile industry. We have noted that cotton warps are sized only to improve weaving conditions. In the subsequent operations the size is boiled out. In carpets, the warp yarns, both jute stuffer and cotton chain, are sized to improve not only weaving operations, but to give a good body to the finished carpet as well. You will readily appreciate that care must be used in selecting this size to produce a maximum amount of stiffness without causing the ends to break in beaming or in weaving. Shedding of the size must also be kept down to a minimum. Unlike the cotton mills, the fill-in is also sized, and this is done in the cops, which are used in the shuttle while still moist or damp. Here is a cop which is rather tightly woven. These are packed into cans and immersed into the sizing solution. It has to penetrate into this cop. For cop-sizing, a dextrine or gum must have good penetrating powers. These operations apply to tapestries and Jacquards. In making axminsters, no sizing is used before weaving because of the nature of the operations. It is necessary, therefore, to apply a back-size

to the finished carpet. The size must have a high viscosity and must not penetrate through to the face of the carpet. After drying, the carpet must have good body and flexibility as well.

In the rayon field, one of our gums is being used in skein-sizing with good results. For this type of work the gum must not only size well, but the skeins must also shake out easily.

Cornstarches, dextrines and gums are employed extensively in the manufacture of adhesives which can be applied cold. They are used in making paper boxes, paper bags ranging from small grocery bags to large cement bags, board lining, manufacture of paper cartons, and in automatic machines for sealing cartons and fiber shipping cases. Paper mills consume large quantities of starches, adding some in the beaters to improve the finish and to increase the strength of the paper. When finish alone is desired, a gum or thin-boiling starch is applied as a top size on the finished sheet.

Closely akin to the paper mill is the asbestos-paper manufacture. Asbestos fibers are hard, shiny and not absorbent, and a sheet of asbestos paper would not hold together without the aid of a binder. Starch is used for this and is added in the beaters. Asbestos pipe coverings are generally covered with cheesecloth, which is pasted on with a cold water-soluble corn product.

You may be surprised to learn that some of our products are used in foundries. In casting metals, sand molds are used, and to form channels or irregular-shaped cavities in the castings sand cores are inserted in the molds. One of our products, Kordek, which is a dextrinized starch, is used as a core binder, and Mogul, a starch product, is used in sand for facing the molds and for some core work also. I have a sample of Mogul here; it forms a plastic mask readily. Cornstarch is used in the food industries, such as baking powders, puddings and pie fillings.

In bread baking, our crystallized sugar, Cerelose, is employed. As it is pure dextrose, the yeast can act on it readily, and hence the setting or fermentation period is shortened and production speeded up.

The dextrines in the corn syrup are the constituents that make corn syrup so important to the confectioners. They are the compounds that impart the body because of the viscosity of their solution. Because of the protective action of these colloids the crystallization of the sugars is repressed and allows control, so that products like fondants, creams and marshmallows can be made. The dextrose also has a tendency to form supersaturated solutions with cane sugar, and this aids also in controlling crystallization. In hard candy, corn syrup is practically indispensable. Here again the compounds in the corn syrup act as repressers of crystallization through the protecting colloidal action of the dextrines and supersaturated solutions of the dextrose and sucrose combination. In hard candies, which are really solid solutions, the high viscosity imparted by the corn syrup solids also prevents crystallization. Invert sugar represses crystallization of cane sugar, but its action is not as pronounced as that of corn syrup. Invert sugar is also more hygroscopic and causes stickiness, especially in hard candy. Corn syrup for the candy trade has to be carefully neutralized, as it would cause an undesirable inversion of cane sugar during the making of the candy. A pH of 5.0 is usually best suited. Each batch, however, is tested for its actual inverting power on cane sugar, which has to be very low before it is allowed to enter the market.

Corn sugar is listed in the U. S. Pharmacopoeia, Tenth Edition. In this form it is the hydrated crystal containing one molecule of water of crystallization, equivalent to 9% water. The purity on the dry basis is about 99.85%. This product is sold under the name "Dextrose, U. S. P. X." It has been received with approval by the medical profession. Dextrose U. S. P. X. is prescribed for special cases of infant and invalid feeding, and has a wide application as a therapeutic agent, injected intravenously in various pathological and surgical conditions. It is the only sugar which may be introduced directly into the blood-stream and become immediately available.

Corn syrup is one of the important raw materials of the candy manufacturer. It is necessary to give proper body and texture to candies, and in some instances prevents crystallization of the cane sugar. Corn syrup is also used in the manufacture of chewing gum. Tanneries employ corn syrup to assist the tanning extract to penetrate into the leather and to give it some flexibility.

There are many other applications of our products, but in passing I shall only mention the names of the industries, not because they are not important but because time will not permit of fuller details. They are laundries, rubber goods, cordage, fireworks and explosives, coal briquettes, crayons, dry batteries, papier-maché, and composition dolls. You will agree that ours is a large field. However, our company strives to learn as much as possible of the requirements and usages of the various industries which we supply, so as to render better service and to purchase products best suited to their needs.

I have covered this field rather hurriedly, I might say; I did not go into fuller details, because I did not know how much time would be allotted to me, and also thinking there might be some questions that

would be asked. If I haven't covered any of the subjects that might be in your minds, I will try to do so if you have a discussion period. I want to thank you for this opportunity of coming to you to tell you of our industry and to thank you for your close attention.

Discussion

Question—Is there a commercial product on the market which contains cold starch and gluten, or both separately?

Answer—This product Mogul contains both starch and gluten. There is not a product in the ungelatine state that I know of, if that is what you refer to; but this is a gelatinized, as stated before. I have requested our company to put out a product such as you speak of in the ungelatinized stated. They have it under advisement now. This would do the work of the product in the ungelatinized state, and in some cases is better because it requires no cooking. You can build up a more concentrated size with a product of this kind than if you take ungelatinized and cook it. In making the starch paste, the starch is absorbed, as you probably know from handling it. It requires from three to eight times its weight of water. You can't get a mixture of gluten starch and have it concentrated if you cook it. You can have as little water as you require, because it will pack up the water and form a heavy plastic mass.

NOVEMBER MEETING OF THE LOWELL JUNIOR SECTION

ON Friday, November 22, the Junior Section of the A. A. T. C. C. of the Lowell Textile Institute held its first meeting of the season. The first business was the election of officers for 1929-1930. The following members were elected:

President—Earle R. McLean.

Vice-President—John W. Stewart.

Secretary-Treasurer—Alfred J. Carbone.

After the elections the first matter to come up was the engagement of speakers to come to the Institute to give the talks on texile chemistry or allied subjects. Several suggestions were made and plans made to see about obtaining certain men in the near future.

ALFRED J. CARBONE, *Secretary-Treasurer.*

DECEMBER MEETING OF THE RHODE ISLAND SECTION

THE December meeting of the Rhode Island Section of the American Association of Textile Chemists and Colorists was held on Friday evening, December 20, 1929, in the rooms of the Providence Engineering Society.

Dr. Donald H. Powers, chief chemist of the United States Finishing Company, gave a very interesting talk, entitled "Rubber and Its Application to Textiles."

About forty-five members were present.

A. NEWTON GRAVES, *Secretary.*

Rubber and Its Application to Textiles

By DR. DONALD H. POWERS

United States Finishing Company

MY object to-night is to say a few words, first, on rubber structure, and secondly, on its application to textiles. If I can impart to you gentlemen a little of the enthusiasm which I feel for rubber, which is perhaps the most outstanding and remarkable substance known to mankind, I will have accomplished my object.

First of all, rubber is stronger than iron, will outwear a piece of steel, stand more dilution than any other compound. It is one of the most remarkable substances, because of its versatility. A specific case is the case of a rubber heel. Actually, we should say a "clay" heel. The best on the market is 15 per cent rubber; the rest is clay. In the case of rubber tires—we call them rubber tires—we ought to call them carbon black tires, it being the gray carbon black; they are from 20 to 30 per cent rubber. With rubber we are able to remove the marks of lead pencils from a piece of paper. The ordinary one contains from 1 to 2 per cent rubber. Rubber retains its peculiar characteristics even when diluted 99 per cent.

The important thing to consider first of all is the source of rubber. That is latex. Latex comes from the rubber tree. Over 90 per cent of the rubber comes from latex, and the variety of the tree is called *Hevea Brasiliensis*, which is the tree under cultivation only in the torrid zone. Latex is not a sap from the tree. It is found about 4/1000th of an inch below the bark, little capillary tubes, twenty to forty in number, next to the bark.

In tapping a rubber tree, to cut the rubber cells, it takes a high grade, technical observer. The tree is cut with a little square down one edge covering about one-third of the distance around the tree, two to five feet above the ground. Rubber trees cannot be tapped until five years old, and then regularly. Actually, a rubber tree, a good one, will give on tapping, on the average of ½ to 1 ounce of rubber a day. Trees 30 to 40 feet tall only give ½ to 1 ounce a day. That is the reason the important thing on plantations is labor. It is necessary to get from an acre of land 4 to 5 pounds of rubber a day. The biggest hope for lower prices in rubber lies in bud-grafting, similar to the way we have of grafting a high-grade apple tree on an old stump. It has been shown that it has been increased to 100%. With 2 and 3

ounces on a single tapping, it then gave 4 to 5 ounces. When you come down to it the actual tapping of rubber is not an efficient operation. As collected, it is in the form of a white milk which you couldn't tell from milk except for its odor. The structure of that latex is about 70% water and 30% rubber hydrocarbon. Some of the older trees go as far as 40% hydrocarbon. If you take the leaves, instead of tapping next to the base of the tree, take the branches and leaves, you will find some rubber, but it is not worth the trouble to get it. The yield is very low and the size of the rubber particle is very small. We find an average content of 30 to 40% rubber hydrocarbon. In addition, there is probably 2 to 4% of what they call rubber resins. Some years ago, after considerable extensive work, an investigator isolated these and found they were able to be crystallized. In addition, 1 to 2% protein. The protein is extremely profitable. It is believed to be very much like the protein you find in corn. There is a small amount of sugar. They are relatively small and undoubtedly by-products in the tree when getting liquor from the tree. There is a very small amount of natural antioxidants.

The less we handle rubber the better it is. Take straight latex as it comes from the tree, that has not been hurt or broken down. It has been known to last from three to four hundred years, and the rubber we think of does not, because rubber is not essentially a remarkable aging compound, but because we, in our process of working it, break it down, dilute it and break it down. The structure of the rubber in the latex has recently had a considerable amount of research, and the results have been some of the most remarkable work carried out. Under the microscope they had long thought rubber was in the form of globules, and Henry stated the rubber was in the form of globule particles with an average diameter of ½ to about 3 u. They have been taking a large amount of photographs and found that in a majority of cases it was not a sphere but a pear-shaped particle. An investigator in Japan has shown some are so shaped, but rarely are they spherical. You can see them turn over in the microscope and become oblong. A particle like this viewed from above would look spherical. No explanation has been satisfactorily given as to why they are pear-shaped or to what it contributes to its properties. But rubber of a pear-shaped particle comes from better trees. It is better rubber.

I might say, in passing, that while *Hevea Brasiliensis* is the chief species, some of our rubber comes from *Ficus Elastica*. It is the common variety; it is not particularly high grade.

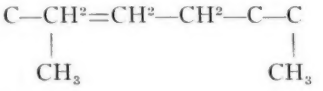
Another brand is Belata. It is used in golf balls and is tough and has to be handled differently. There is an American-grown product, Guayule. It has been grown in New Mexico by the Continental Rubber Company, and they have been doing considerable work on it. It is a shrub which grows a height from the ground, but the globules do not exist in the cells, but is apparently in the colloidal dispersion in the sap of the shrub. They take the shrub and cut it up and extract the Guayule and throw away the rest. Guayule contains from 20 to 40% resin. It is a sticky mass of little value, but they have recently worked out a practical method of extracting, and it is at present on the market in tires, somewhat of a cheaper compound to put in with good rubber. Guayule is perhaps a threat for home-grown rubber in case we can't get products from abroad. It is perhaps the best source at the present time. Not so many years ago a man went to the rubber company with a product. They examined it. It was of no particular strength but somewhat plastic. He said, "I can give you this for 4 to 5 cents a pound." They said, "Fine, we can use it in our rubber." He said, "I will tell you how I make this if you will pay me so much. I get this from milkweed." The rubber company has not taken that over. The number of acres in extraction for the quality of the rubber is not practical. Osage Orange has the latex in it which is rubber-like. At the present time we are reading editorials about Edison experimenting on goldenrod. They may or may not have practical value. Personally, I feel Guayule is the growing substitute in this country.

To turn to the structure of latex, we find it is in the shape of this pear-shaped globule. There was a long discussion as to why that globule was that shape, and how it came to be that shape. About five years ago Hauser was able by a microscope to dissect this rubber *Hevea Brasiliensis* particle under the microscope, with a moving picture camera above it. He took moving pictures of a single globule. When you consider the size of it with an ordinary microscope you can appreciate it. When he pierced the side of his globule, a serum or thin-like liquid oozed out around his needle. Since that time the theory was advanced that rubber is made up of two hydrocarbons: a highy resinous tough part and an inside viscous liquid. In other words, rubber owed its properties to the fact that it was not a single substance, but a mixture of two or perhaps two hundred. Balata is not accepted to be a mixture; it has no stretch, no resistance to tear and abrasion. It has been shown to have a coating of resin around each globule, perhaps one molecule or perhaps larger, or similar to corn protein.

The acids are on the outer surface, so that actually in latex you have myriads of globules with a thin liquid inside and a thicker outside. When you add hydrochloric acid to that acid you get coagulation. It occurs at the point where you isolate it by itself. It is apparently doing the most to the protein. It is a soft, spongy mass you pull apart.

You work it together and force the water out, and it gets stronger and stronger. If you coagulate a piece of rubber latex, the average person could not tell the rubber from ordinary rubber. It has a high tensile strength. The only difference a piece of coagulated rubber has from latex, it would be brittle. It you brought it in here it would become quite sticky. Rubber, as you get it from the tree, has remarkable elasticity. It is susceptible to change. It is merely the changing of rubber to a product which is no longer sensitive to temperature. Vulcanized rubber is very much like ordinary rubber except it is sensitive to temperature.

In going on with the structure of rubber, I might say the rubber hydrocarbon is made up of long chains of hydrocarbon. Rubber has always been called C_5H_8. There has been controversy as to whether it has a molecular weight, as to whether it has u. Recent investigations of the X-ray have shown rather clearly that in the rubber hydrocarbon you have long chains, perhaps not more than 400 carbon atoms long, a chain of this sort:



The work of Carothers has recently shown that when you work with ordinary compounds, short simple compounds. When you deal in compounds real long, if our microscope was a bit more powerful and with our X-ray we can measure the length, particularly compounds containing an oxygen group, long chains of compounds have a residuary second valence and have a tendency to haul another chain just as though they were bound together by an irregular chain. As a result, in rubber we have this:

Treat your rubber right, heat it—you will see it is a result of that group of chains. Treat it differently, you will get one-half as many, or one hundred times as many. They are actual chains swollen by thin viscous liquid When you stretch rubber, it suddenly becomes crystalline. That is the story as they tell it. The present view of the matter is that rubber in the unstretched state are swollen by the inner viscous material so that there is no longer direct orientation. When you stretch it you drive out the inner viscous liquid. When it is elongated you get a crystalline product. If you take a piece of rubber and freeze it, it suddenly becomes crystalline. In freezing, the theory is that the solubility of it dries out and once again you get orientation.

Why is rubber so elastic? There is a tremendous amount of work being done as to why it is elastic. It has a tensile strength, 6,000 pounds per square inch. It is based on the original cross-section of rubber before you start to stretch it. A piece of rubber, 1 square inch of rubber, it takes 6,000 pounds to break it. It is quite strong. Fessenden in the eighteenth century suggested that perhaps the reason that it was elastic and plastic was due to the structure. You could explain by assuming that you had a ball filled with liquor. Take a rubber ball and squeeze it. Let the liquor go and it goes back again. Part of the elasticity or rubber is due to that structure. They recently made an inner tube from latex, from rubber which had none of the globules broken, and that tube could not be torn by a trained athlete, due to the fact that in the tube you had these globules all through it, and when you started to tear you come to the middle of a globule and couldn't get away from it. It has much higher elongation, greater resistance to tear. The other property to elongation, you can break down these globules. Hauser wants to make it clear that rubber hydrocarbon itself, or the two hydrocarbons, are essentially elastic, and even though you synthesize the structure, you wouldn't necessarily have an elastic like a bed spring. That was suggested by a man named Barrows. Clark himself in Philadelphia mentioned the fact that in rubber hydrocarbon you have it curled up like a bed spring. It is just that way in space. In pulling it out you pull out that chain. Hauser said you can predict it would stretch 7 to 800% before breaking, when you don't put clay and starch and gums into it. At the present time rubber owes its properties to a combination of facts, first of all, that hydrocarbon is a long hydrocarbon, coils up, and contributes a group of globules to the hydrocarbon. Its average molecular weight is 400,000 to 450,000. Belata is reputed to be a compound with a lot of these in its average bundle. It is extremely tough, relatively insoluble in most parts. It is close to a million.

No discussion would be complete without some mention of synthetic rubber. One reason for the synthetic is to keep the price of rubber as an economic threat in rubber. Within the last few months editorials have appeared that it is around the corner, and is being held as a threat against rubber. Personally, I think there is some truth in it, for patents have appeared which show they have nearly got synthetic rubber. During the war the product that appeared was not rubber; it may have been a product with a slight stretch like an ordinary sponge, with no elongation, or an elastic product with no stretch, or else so-called hard rubber. Hard rubber is no longer elastic. In the question of synthetic rubber, there are probably two big factors. There is no question that it is one of the biggest technical problems ever tackled by an organic chemist. First of all, you must have a cheap available hydrocarbon. The unfortunate part is that that is only the beginning. Assuming you had it, you have got to convert that into the structure that will give it elastic properties. Isoprene was the natural starting point, and because somebody once got a few

grams when distilling rubber, it has been thought of as the starting point. Assuming there is cheap ordinary isoprene, isoprene gives a tough plastic mass with practically no elasticity. Once you have got your hydrocarbon you don't get rubber unless you polymerize it with this sort of thing. It is a physical chemist's job as well as a job to get the patent. According to the late Pry, the work was done with the idea that rubber was a plastic solid. They took a piece of isoprene and put in a certain amount of catalyst to make its molecular weight big, and got a plastic mass. All of the recent patents, particularly those taken out in the past year, point out they are thinking of rubber in the terms of latex, its original source. They are putting it in water, thinking you may get a high power on the outside and a lower power on the inside. Theoretically, it may be possible to synthesize a synthetic rubber. There is no question but what rubber prepared in that way is very near to what we think of as natural rubber.

An interesting property of rubber is that practically all rubber is used commercially. It is made from milled rubber. Latex coming from the plantations is in the form of big bales. They sheet it out, passing it through a rubber mill. You get a friction effect, and it takes a tremendous amount of rubbing to break down rubber. What actually happens is that in milling rubber you break down a certain number of those gobules—10 to 20, maybe 40, per cent of those globules —so that ultimately you have in milled rubber no longer a mass of globules tough and hard, but a mass surrounded by a viscous liquid. It is true of milled rubber. The explanation of the property taking place fits in with what you do when breaking it down. If you milled rubber cold you break it down; if you mill it hot, it leaves the idea that this liquid is a lubricant. When cold, you break down cold globules. Cold rubber is dead; it has lost its life. Vulcanization of cold milled rubber brings back, to a large extent, its properties and makes it look like latex which has not been milled at all, except that it is no longer sensitive to temperature.

In the processing of rubber the first step is coagulation. This approved method of coagulating is to let it stand overnight, adding a very small amount of dilute acid. With concentrated acid it coagulates at once, but you rather get a good formation. Spray dray rubber has the advantage or the difference from ordinary rubber, in that when you ordinarily coagulate rubber your water solubles, your sugars, form resins and salts are removed, but when you spray dray you get them all in there. You get an additional yield out of your latex by spray dray. Spray-drayed latex is extremely tough. It takes a tremendous amount of labor to break it down. Freezing rubber is also a method of coagulation, if you freeze it right and do it long enough. If you want it to freeze, use alum in dilute. Instead of getting coagulation you get a flocculation. Press it together; the moment you press it, it coheres into a uniform sheet. With your solution that way you get a flocculation instead of precipitation. With the electro-deposition method in the presence of acid you get coagulation of rubber. This happens to be a sample of electro-deposited latex. By means of electro-deposition it is possible to get rubber in the shape you want it without milling it. If you take the handle of a knife and want to coat it with rubber for putting handles on dentists' instruments, put the handle in the bath and you get a coagulation of tough hard rubber. In other words, you have a sheet of rubber in sheet form which has not been milled to bring it in that state. This has not been vulcanized. If you put it on a piece of ice it would be brittle. Other than that, it acts like a piece of ordinary rubber.

At the present time, in tires in a hundred parts of rubber there are probably 100 parts of carbon black. Ordinary tires with carbon black wear better than with pure rubber. It is justified by the fact that tires now last from 20,000 to 30,000 miles instead of 2,000 to 3,000 miles. I might say thermotomic black has no such compounding effect. If you take an ordinary rubber with a tensile strength of 3,000 compounded with a good high-grade black, its tensile strength will step up to 4,000 or 4,500. With a thermotomic black it doesn't have the reinforcing power. If we have a carbon black with a high absorbent power, it acts as a mattress to hold it together. If it is not, in the case of clay or whiting, they are merely filters. Put them in and they dilute the rubber. Stearic acid is one of the best acids; it softens the rubber. Pine oil is another product used. Benzidene is a stiffening agent. Take a little rubber and mill into it some benzidene; let the rubber get stiff and you will think the rubber is vulcanized. Actually it is due to the rubber compound, Para Amido Phenol. It will actually stiffen the rubber up and remove its stickiness.

Then the process of vulcanization. It is the outstanding discovery of rubber. Unvulcanized, because of heat sensitiveness, it could not be used. You know the history of the spilling of acid, etc. A Russian chemist is now publishing some work he did a good many years ago on the vulcanization of rubber by oxygen. Apparently what happens in vulcanization, you get a combination of two effects: one effect is that in the presence of sulphur and catalyst your rubber resists temperature and abrasion. In addition, a certain amount of sulphur combines with the bonds. The shorter your cure of the rubber the better the rubber. The heat is breaking it down; the sulphur is

building it up. The quicker you build it up the better. It takes three to four hours to convert rubber from the plastic milled condition to ordinary raw rubber. If you cure the rubber in one hour instead of three hours, the tensile strength is doubled. We can cure rubber in a minute now, due to the fact that in the vulcanization we don't break it down due to the heat. Organic accelerators have been a contributing factor to the fact that rubber is so much better than it used to be. You can cure rubber at 5 pounds steam pressure in one minute. Organic accelerators are all of a type. They are of a certain variety, but largely derivatives of aniline. You can classify them in half a dozen simple groups. If you take aniline and aldehyde you get <—> NH_2 + CH_3CHO. Take aniline and react it, you get DPG and DOTG. They are all coming back to the aniline class. If instead of using aniline and carbon sulphide, take diamethalamine, you get $(CH_2)_2NH$ + CS_2. They are pure and of little value. Put them in rubber and try to make a tire out of them —before you get them into the mold and out again the tire is formed. The outside of your tire would be almost brittle from overcuring and the inside not be overdone. At the present time a well-constructed tire is cured with three or four concentrations. Your heat comes from the outside; you have the slowest accelerator outside and the fastest inside. At the present time, where it used to take two and three hours to cure a tire and you had failure of the side wall due to the fact that the rubber was not properly cured, at the present time you have the whole tire cured up to the best point of where the abrasion is to be. Sometimes it is cured in one-half hour. One hour is the time that it can be cured safely in contrast to three or four hours.

In compounding rubber you have to mix up your filler and zinc oxide on the rubber mill. That milling takes up so much energy that the rubber gets hot. If your accelerator is so active that it cures about 100, it will cure before you get it in the rubber mold. If so, you might as well give way. It doesn't flow any more. They long thought nitrogen was essential, but the curing cements on the market to-day contain zanthates. You get zinc salt. It takes 2 to 3 per cent of zinc. Shake it up; within two or three days you have a very good cure. Incidentally, this compound is a fugitive accelerator. If you try and use this accelerator in the usual curing temperature, you would say it was not negative.

The question of aging is probably one of the important questions of rubber. Only in the last few years have we learned how to prevent the deterioration of rubber. It has made rubber a far more valuable product than ever before. The more you break it down the purer it ages. Within the last few years we have developed organic bases—paraphenylenediamine; the peculiar thing is that it is tremendously sensitive to oxygen. The workers at the Bell Telephone Laboratories have found that if you have a hundred pounds of rubber and one-half a pound of oxygen gets into that rubber, its tensile strength drops; its practical value is gone. A very small amount of oxygen has a bad effect. What apparently happens is that it will go into a sticky plastic mass. You will get oxide of rubber. Then the breaking down of rubber—it is particularly sensitive to copper manganese and iron. Jones showed that the addition of copper increased deterioration of rubber. One-half of one per cent of iron caused deterioration. Copper and manganese are catalysts for the decomposition of rubber. What happens to be a nice piece of rubber, if there is copper in it, won't be good for the trade. That is the reason that the textile trade insists it must have less than five one-thousandths of 1 per cent in rubber. You will realize, if you see it go bad, that it is not asking too much. If the copper doesn't get into the rubber it doesn't hurt, but if it does I think you will generally agree that the rubber will sooner or later go bad.

I will mention another method of vulcanization—that is, the sulphur chloride cure. You will apparently add sulphur chloride and get a compound with rubber. It has a practically instantaneous reaction. It is applicable only to very thin sheets of rubber. It is instantly vulcanized rubber. Ordinary, practical dental rubber is made that way. Sulphur chloride rubber is not as strong nor does not age as well as press-cured rubber, although it is a convenient way of curing it. In sulphur chloride curing, wash out all the acid with ammonia thoroughly; otherwise the trace of acid will cause the material to go bad.

I might say ozone or sunlight has an entirely different effect on rubber. It forms a bond. The ozonite tends to coat the surface. Some recent work has been done exposing it to ultra-violet. It forms a thin film which protects the rest of the rubber. If you form it on the rubber you protect it, which is in contrast to the copper in the rubber.

Organic colors are replacing inorganic. One of the biggest problems is to match inorganic shades. In the old days the old hot-water bottle was that color because of ammonia sulphate. The organic color is very superior, in that you use 1% instead of 10% of the other. The aging properties are improved, provided you select the right colors. You have a far wider color range and varieties of shades somewhat harder to get with a pigment.

Application of rubber to textiles: the reason that it

has not been applied to textiles is that it is the late end of two big fields. The rubber end has been so busy and never worked on the application to textiles, and the textiles never worked on the application of rubber. One of the chief reasons for its not being used is that it has been neglected. The possibilities are tremendous. The application of milled rubber in the form of sheets, giving good aging rubber that will last as long as our cloth and getting it into the cloth, are tremendous possibilities. It has been more or less isolated, separated end of two big fields.

The last few years have seen a big growth in actual rubberizing of fabrics. I think this year there will be fifty million yards of cloth rubberized. The biggest single item is the use of the cord tire. The cords in tires are rubberized. In your ordinary rubber tire they are passed in a solution of benzine or in the latex. For raincoats and auto tops it amounts to perhaps fifty million yards. Of that fifty million yards, probably 30 to 50% is in raincoats. The other fraction on the market is in auto-top material. In that the rubber is rarely on the outside; it is usually in between with a coating of cellulose above it. Rubber is not adapted to sunlight, for it becomes brittle.

Another limiting factor is the aging proposition. Until recently the average person thought of rubber bands as lasting a very short time. Actually they could be made, if they would, to outlast the manuscript with which they are used. Another limitation is the fact that you can't get a clear colorless film of rubber, although when it is highly purified it is water-white. Commercially it is a yellow film; you can't use it for coating. That is a further limitation of its use.

Summarized: No work on it, the lack of study; secondly, the aging and effect of sunlight; finally, that it does not give a colorless film. In applying rubber to textiles you spread a drop on the cloth, or take a sheet of rubber similar to this sheet here in the unvulcanized state and friction the calendered side of the cloth. Those constitute the two principal methods of coating fabrics. Each type has its adherents. You have to be careful your acid does not affect your colors or cloth in the curing of the spread rubber. The other possibility is that you put in a dry-heat accelerator. It cures in the class of the tetramethylenediamine. It is a dry-heat method, 240° F. Put it in for two hours and it is vulcanized. Your cloth must stand those conditions. Instead of using a benzol solution or a dispersion of latex, it is possible to mix a solution of this class. Let it dry on the cloth; it will cure itself. Your rubber is presumably a tougher and better age. After the coating is on, there is the after-treating of rubber. Milled rubber is always tacky. Potato starch is used for the electric: improved starch is by far the best, they claim tapioca. Cornstarch is chiefly used in covering for cheaper grade work. Mica is sometimes used, but gives a glistening effect; is used for special effects. Instead of dusting with cornstarch, dust with cut fibers, cut silk, wool or cotton. You get unique effects. For special effects, if you want a rubber coating, dust gasoline compound with enough glue and you will make it repellant to gasoline. In case of tires you use carbon black. Mix it; you will get a coating that will stand a tremendous amount of wear. If you want a coating with a high gloss and smooth, put a large amount of filter in it; if you want to resist gas, make the gas cloth for parachutes, use viscose compound and get a mixture of cotton cellulose. Properly handled, you get a film that is gasproof.

For novelty effects there are lots of possibilities. Put color in rubber and don't mix it up; you get what the English call a "jazz" effect. You get streakiness of color throughout. To do it intensely, it is good; but if not, not so good. You can print a certain amount under a given stretch and then increase the stretch a little farther along. When finally released, you once again get a novelty. Take balloons; blow up, dip in color, and you get a novelty effect. They are printing colors on rubber with wooden rolls, as well as a certain amount of block printing on rubber. Dyeing under tension color of balloons is the ultimate test of dispersion. You can tell in a very short time whether it is perfectly dispersed.

Finally, the applications of rubberized fabrics. The chief ones are raincoats and auto tops. In addition, they are doing rubber hospital sheeting, a coated fabric on both sides. They are taking a jute, a hemp, forcing it through burlap, anchoring it to the burlap and coating it with latex. You get a firm anchorage. They are working on toys and collar buttons at the present time. I hope when they make the collar buttons they will utilize the elasticity of rubber so that it will bounce back.

Discussion

Question—Anything to be added to rubber to prevent the act of light? Such things as light filters like anthracene?

They will take a short length and change into a longer length. Generally speaking, unless you paint a darker color—they aren't of any real value. What the sunlight really does is not absorb the light but form ozone on the surface. Very small amount of ozone is the thing. They are working on it at the present time. As far as that goes you must make it opaque.

Question—Any work being done to treat the cost of

an anti-copperant to prevent the copper from acting on the rubber? It is rather difficult to get cloth that is less than that?

Davis showed paraphenylenediamine retarded the action on copper. If we could find some copper salt that didn't act on rubber. Once a company put out by mistake a copper washer on a rubber heel and it went right through. Enough antioxidant will retard action but the first thing is the rubberizer. There has been endless trouble already and is going to be more as easily.

Question—Give me an example of a printing paste?

A printing paste for printing on rubber would have to be preferably a benzol printing paste made up of very thick rubber benzol highly compounded in zinc oxide and a certain amount of color. You have got to have a certain amount of solvent. Zinc oxide is one of the best pigments. In other words, a regular printing formula wouldn't work.

Question—Is that for printing on rubber?

Yes. Ordinary water just washes off in most cases. Unless you could have a water dispersion of benzol. You have got to have something of that sort. To print on rubber you use rubber cement; otherwise it washes off.

Question—That might present problems in an ordinary printing establishment?

Engraving is different. It is not the usual type of engraving. An ordinary printing machine can do it, but the formulas are valuable.

Question—Impregnating cotton fabrics with latex and a cure at ordinary temperatures—is it possible to have the cure so regulated so as to stop curing at a certain point?

Yes; by control with your accelerators—the danger of overcure. You put in 2% sulphur. The sulphur is used up until there is no cure. There are certain flat curing accelerators. They will cure to a peak; if you overcure five minutes it is no good. If the correct cure was six minutes, you could cure for six hours, and it would be all right; there is quite a range of flat curing accelerators.

Question—Impregnating fabric with latex, would you have to use benzol solution?

No; there are some patents out now—impregnating fibers with rubber is a problem that needs study; you have got to be sure of penetration.

Question—You think impregnating with latex would have better resistance to friction than ordinary?

They claim so. There was a patent in an actual case. I saw some fiber impregnated with rubber and they claimed it would mat together; it held. The rubber itself was so resistent to wear. In addition, it would be porous. It is not porous usually. They claim impregnated fiber sold would be cheaper and wear better. It is a question of getting the right curing condition. There are possibilities.

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The lapel button badge illustrated herewith is worn by members of the American Association of Textile Chemists and Colorists.

The three "rings" are enameled in red, yellow and blue, respectively, and the initials and border are brought out in gold. The general effect is exceedingly attractive.

Badges may be secured at $1.50 each by addressing the Secretary.

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CREDIT FOR THE NEW IDEA

MORE credit is due the man who accepts and uses a new idea than to the one who suggests it. What? Yes, this is a bit contrary to some of our cherished notions, but isn't it true in very many cases? To be sure, many new ideas are thought up and fought for by some one individual and put through in spite of opposition and obstacles. In that case the new idea is carried out under orders, but we are now thinking of the ideas that pop up in discussions around the mill, are found in laboratory reports, or are dropped now and then by our superiors.

Our whole material progress hinges largely on new ideas. Some of them are flashes of inspiration; others are of the type that anyone in the same circumstances could hardly help thinking of; and others are the result of much real thought and study. New ideas are plentiful enough, but for one reason or other most of them fail to do much good, aside from setting us to thinking. Then if perchance one of them does work out, there is often a grand scramble to get credit for it. But, in the final analysis, let us say again, more credit is due the man who accepted and used the new idea than to the one who merely suggested it.

It seems to be a natural trait to want to give advice, and an equally natural trait to prefer not to accept it. New ideas are merely another form of advice, but they deserve more than the usual attention.

Of course, equal respect is not due all new ideas, and one must consider the source from which they come. Some notion of the company treasurer will send foremen and superintendents scurrying in the hope of scavenging a few crumbs of glory, while the brightest idea of the chemist may fail to start a ripple.

Omitting the exigencies of plant politics, any new idea that sounds the least bit practical, or that comes from a responsible source, even if not so attractive, should have a fair hearing, and then perhaps the other kind of a trial, by experiment.

Some individuals are very enthusiastic about all sorts of new ideas, but usually manage to forget the last one in time to receive the next. They never get beyond the good-fellow and hot-air stage. The other extreme is up in arms at the faintest suggestion that something in the present order of things could perhaps be changed to advantage, and regards any suggestion almost as a personal affront. We can only wonder whether or how these people expect to get anywhere.

Some men seem to want to make the management believe that everything is going the very best possible, and that ideas from outside are unnecessary because the present conditions cannot be improved. Any new thing tried is pretty sure not to work.

Another, and much happier viewpoint, is to try new things, to give them rather more than a fair trial if they look at all good, and to depend for success on the fact of being always up to date, and being able to say, "There is nothing new in our line that is at all promising that we have not given a thorough trial."

Somewhere in between come most of us, not keen to have someone come in and show us how to improve our work, but still anxious that it should be done better, if possible. So we present our excuses and arguments, but mull it over and try something that is embodied in or suggested by the new idea.

This trend of thought suggests in turn another suggestion, that it is sometimes profitable to indulge in a little self-analysis. Self-analysis requires a scientific mind (which is not found exclusively in scientists) in order to see the facts the way they really are.

A recent writer, who, like all popular writers, is immediately hailed as an oracle or a sort of universal authority because of having written a "best-seller" novel, says that the way to a man's heart, and evidently also to his purse, is to harp on the "Aren't you wonderful" until he falls for it. A good deal of the self-analysis just gets to the "Aren't I wonderful" stage and the analyzer is quite happy to let it remain there.

The reader might even get a new idea of stopping to think just how he received the last few suggestions that came his way.

Therefore, and to whom it may concern:

Give encouragement at the source of new ideas by extending credit for them; then if it comes within your province, give credit for the often greater mental effort of accepting the idea and making it go. And, if you yourself happen to be the one to make it go, do not be too modest in claiming recognition.

THE ECHOES TO MR. GARVAN

THE country awoke a short while ago to discover on the front pages of its newspapers the charges made by Francis P. Garvan, former Alien Property Custodian, of interference by German interests for the express purpose of creating a tariff which would have hampered, temporarily at least, the American dyestuff industry.

The following day there were still more dispatches which contained denials even more vigorous than were the original remarks by the president of the Chemical Foundation.

Evidently, there was no middle ground or twilight zone; the horizon was either very dark or extremely light. It seemed advisable to wait until both sides of the question had been voiced definitely by proper authorities before attempting to arrive at a fair and just appraisal. Since then there have been further statements by Mr. Garvan and counter-statements by the other side.

The significant point in the whole matter comes in the fact that there have been few, if any, releases to the press by executives of the large American firms which would, according to Mr. Garvan, have been so completely crippled had this diabolical campaign succeeded. And quite likely both sides are misinterpreting this silence; and, in addition, the innocent onlooker is completely at a loss.

A wag has suggested as a thinkable possibility that the American interests are remaining quiet lest Congress take offense and so construe their remarks as indirect lobbying, and hasten, necessarily, to summon the spokesmen before an appropriate committee.

All must admit that this might prove most unfortunate in view of the fact that dyestuff provisions of the Tariff Bill are so close to final consideration at the present time.

One of the New York dailies quotes a representative of Colonel Metz, of the General Dyestuff Corporation, as affirming that "95% of all the dyes are made in this country." This statement is, on the face of it, extremely ambiguous. The assumption is that reference is not made to the total world production as this, naturally, would be utterly ridiculous. The conclusion is that he was speaking of the United States production. But, even so, is it the gross according to weight or according to dollar value? There *is* a difference. The Government in their information included in the "Statistical Abstract of the United States, 1929," does not happen to give data pertinent to a gross weight production. But for 1925 and 1927 it indicates that the ratio of imported "dyestuffs and tanning material" to the sum total of imports and domestic production of the same is 19 and 22%, respectively.

IN THE PAST TWENTY YEARS

FROM over the entire country in various ways comes the general manifestation that the chemical industry is working with united effort for the establishment of institutions through which the results of research may be exchanged and opened to all. Practically every chemical society has placed itself on record as favoring this modern movement, one which has gained tremendous impetus of late. Many organizations have gone farther than this. They have appointed or elected committees to give their whole time to the formulation of practical and tangible means for the realization of these projects.

Seldom does there come an objection. When it does arrive, however, it is recognized as the pathetic cry of the *provincial*, who is constitutionally set against progress. Everyone knows the answer which a *provincial* gives when another suggests to him the trend, for instance, to modernize his plant, his home, or his Babbitt-like manner of living: "My friend, I have always done things in this way; I am happy now. I am not willing to take any chances. I admit that while I might possibly gain a little, I still recognize that there are greater odds against it. Thank you, sir, not to-day."

The constitutional objector we all know. We admit that his reasoning is, to him, letter perfect. He will not yield one inch. He is self-satisfied, smug, and totally unopen to criticism. Never does he refuse to give bases for his conclusion. As a matter of fact he likes to. It makes him feel more smug. If we pursue the matter, he immediately becomes furiously incensed. Then he is totally unable to act logically either in his own or in anyone else's interest.

But those whose heart and soul are in support of progress must not slacken pace. If they require encouragement let them look to the pages of history. Our nation is what it is to-day because a few men had not only the strength of their convictions, but the power to act. They believed that the cause which they had espoused was the correct one. Ere long a handful more fell in step—then more—and more.

The ultra-conservatives began to open their eyes. Perhaps, after all, there might be a wee bit of truth in what those others had advocated. Then, alas and alack, they were hoist by their own petard. Consistently had they affirmed their allegiance to the will of the majority. The nation had developed from an idea to a reality. Consequently they, too, became citizens. Need we add that to-day their progeny look with great pride at the family tree which shows one of the "first citizens" at its roots?

Let us all pool our interests in this recognized urge to aid research. Let the forerunners in this movement who can visualize the future act—thus repeating the advance which has characterized the dyestuff industry in this country in the past twenty years.

Recent Progress in Federal Certification of Food Colors

By Waldon Fawcett

Written Expressly for American Dyestuff Reporter

THE addition of the new color, Brilliant Blue FCF, to the list of coal-tar dyes accepted for certification, is by no means the only recent development of significance in the administration of the Federal permit system. The accession of the new blue is, of itself, a notable step forward, because of the fourteen accepted dyes heretofore approved only one had been of a blue shade, i. e., the Indigotine, making unfavorable comparison numerically with three shades of green, four shades of red and five shades of yellow. However, it is in the more general acceptance of the idea of certification that there may be found the deeper meaning of current history in this quarter.

As readers of the Reporter are aware, acceptance by the industries of the Federal certification of food colors must, of necessity, be wholly voluntary. The impression in some quarters that the Government has mandatory authority under the Food and Drug Act is wholly erroneous. The system of certification of coal-tar food colors was set up by the Department of Agriculture wholly as a convenience to producers or processors of food. It is no more than a species of assurance or insurance of which the dye consumer may avail himself without cost if he dislikes to purchase, in the open market, products vouched for only by the makers.

Despite the absence of compulsion there has been a steady increase in the past half decade not only in the volume of coal-tar food dyes certified and in the number of batches, but, what is more to the point, in the number of firms accepting this supposedly benevolent censorship. In 1925 there were thirty-four firms submitting dyes for examination and certification. This roster has grown until the past year has shown a total of sixty-two firms of which ten firms were newcomers during the twelve months.

At the department various reasons are given, and influences ascribed in explanation of the spread of the spirit of co-operation among color manufacturers. Foremost, perhaps, is the gathering pressure from consumers of coal-tar food dyes. As dye users have come to realize more fully that use of non-certified products, whatever the fine reputation of the dyes, transfers to the shoulders of the user all the responsibility for any shortcomings, they have grown more insistent that the dye maker assume this obligation. Indeed, food manufacturers have become aroused considerably of late to the accountability to which Uncle Sam is holding them. Not only in the case of harmful coal-tar dyes is a user liable to prosecution and to seizure of the food colored with the condemned dyes, but the same objections apply to the use of mineral or organic coloring matters. Manufacturers who use organic coloring matters of natural origin, such as vegetable colors, have been pointedly warned that they must assure themselves that such substances are harmless in themselves and free from harmful impurities. Lacking facilities for this check-up, or disliking the bother, there is fresh incentive upon color-users to turn to the certified dyes.

Matching this pressure from without, in persuasion to acceptance of Federal certification, there has come a more sympathetic sentiment within the dyestuffs industry. Makers of coal-tar food dyes have, by closer acquaintance, formed a higher estimate of the compensation that is obtained for the routine of submission of each successive batch. The Government has latterly emphasized to dye users that Certification by the Food, Drug and Insecticide Administration implies not only that the dye is harmless but that it is uncontaminated by poisonous substances. This confidence is founded on the fact that the original list of seven permitted dyes was selected after a critical study of the reports of pharmacological tests on the more important dyestuffs. The additional dyes which were included from time to time have been added to the list after appropriate pharmacological and toxicological tests had proven them to be harmless.

Dye manufacturers have been further impelled to avail themselves of the certification shelter as the word has spread in trade circles that the red tape involved is not actually so formidable as it has been painted. Procedure is as follows: When a manufacturer has prepared his first batch of a permitted dye, intended for certification, a representative sample of the batch must be analyzed by the method prescribed by the department. If the analysis shows that the dye complies with the specifications of purity for that particular dye the dye-maker executes a Manufacturer's Affidavit and Manufacturer's Agreement, in the respective forms, prescribed at Washington, and has his examining chemist execute a Foundation Affidavit, so called.

The three documents mentioned, together with samples —a one-pound representative sample of the batch in the case of a water-soluble dye, or a half-pound sample in the case of an oil-soluble dye—are sent, plainly labeled, to the Food, Drug and Insecticide Administration. In the laboratory at Washington the sample is examined chemically, and if the results substantiate the claimed identity of the dye and its compliance with the standards of purity there is issued a certificate assigning a lot number to the batch and reporting the dye content. Acceptance or rejection is usually made within a period of two weeks. If successful, the manufacturer is empowered to use the batch number on each container in which a portion of the identified batch is packed for commerce. With the reservation that when a certified dye is repacked it must be recertified.

Incidentally, it is to be noted that whereas the production of certified colors is now at the highest point in five years the volume of "repacks" has fallen. In 1925

the repacks aggregated 39,000 pounds, falling to little more than 15,000 pounds in 1928 and rebounding to 28,589 pounds in 1929. The years 1925 and 1926 were periods of high production in straight dyes, but 1929 marked the high tide of the half decade with its total of 337,847 pounds. This gain in volume has been accompanied by a gratifying shrinkage in the proportion of the submitted dyes rejected for failure to conform to requirements. This, in the face of the fact that the tolerances for minimum percentages of pure coal-tar colors range from 85 to 99% in the case of the different colors.

Mention has already been made of the fact that progress has been exemplified significantly by the steady continuous increase in the number of firms participating in the certification program. No less interesting in this respect is the upward trend of the number of batches examined each year. In 1925, the batches numbered 883. In 1929 the total was 1,206. During 1929 the rejections for non-conformity to the requirements of certification comprised twelve batches of straight dye and ten batches of mixtures.

Augmenting the expected increase in the consumption of food colors and an increased adherance to the Federal system of certification it is expected that totals will be sent upward year by year in consequence of the additions to the range of shades. A stimulus has been imparted, as already cited, by the entry of Brilliant Blue. The past year and a half has also witnessed the addition of the new red, Ponceau SX, and the new shade of yellow designated Sunset Yellow FCF. These three additions are not listed in the Colour Index published by the Society of Dyers and Colourists of England. Nor is the Fast Green FCF. But the composition of these dyes may be obtained by interested parties upon application to the Food, Drug and Insecticide Administration.

From the standpoint of chemists, possibly the most meaningful phase of progress in this branch of governmental administration is to be found in the revision of the procedure for certification. Since 1926 a number of changes have been made in the methods of analysis of the permitted coal-tar food dyes. These have been made in part to meet the suggestions of manufacturers and in part as a result of improvements devised by the chemists of the Color Certification Laboratory. In some instances the alterations have called for a variation of the original methods, but in most instances they have been added to the regulations as optional procedures. Presumably the regulations covering the chemistry and analysis will require frequent revision as time goes on, since the approval of each new color will demand the inclusion of a description of the added color together with a table of limits and methods for its analysis.

EDITOR'S NOTE—It may be interesting to the readers of the above article to know that at the present time the list of coal-tar dyes accepted for certification are as follows:

Red Shades:

80 Ponceau 3R
184 Amaranth
773 Erythrosine
Ponceau SX

Orange Shade:

150 Orange I

Yellow Shades:

10 Naphthol Yellow S
640 Tartrazine
22 Yellow AB
61 Yellow OB
Sunset Yellow FCF

Green Shades:

666 Guinea Green B
670 Light Green SF Yellowish
Fast Green FCF

Blue Shades:

1180 Indigotine
Brilliant Blue FCF

The numbers preceding the names refer to the colors listed in the Colour Index published in 1924 by the Society of Dyers and Colourists of England, which gives the composition of these dyes. Names not preceded by numbers are not listed in the Colour Index.

Automatic Apparatus for Analyzing Colors of Transparent and Opaque Objects

An automatic apparatus with which the colors of transparent and opaque objects can be analyzed with a scientific accuracy in less than ten seconds has been developed in the graduate laboratories of the University of Pennsylvania's Department of Physics, it was revealed by Dr. Charles B. Bazzoni, professor of experimental physics at the university.

The device was perfected by Joseph Razek and Peter J. Mulder, instructors in the Department of Physics, to whom the practicability of constructing such an apparatus suggested itself while they were engaged in a problem of pure research as candidates for the degree of doctor of philosophy.

The new "color analyzer" is portable and is built into a box about the size of a large suitcase. It can be operated either by connection to any electric light socket or from a suitable bank of batteries.

The sample to be tested is placed over a small rectangular opening on the top of the box, where it is illuminated by a powerful source of light. The light reflected perpendicularly from the sample is admitted to a spectroscope in which it is separated into its component colors.

A selected portion of the dispersed light is then allowed to pass into a photoelectric cell, the very

feeble current passed by his cell as a result of the light falling upon it being amplified about a million times. This is done by means of a special amplifier, known as a "bridge grid resistor amplifier," developed for the particular purpose.

The amplifier employs two vacuum tubes such as are used in the last stage of many radio sets, with certain adaptations which greatly increase their sensitivity, and the amplifier current is indicated on a sensitive galvonometer whose reading can be noted on a scale on the front of the machine and at the same time recorded on a photographic film.

By turning a small crank, different portions of the spectrum are successively admitted to the photoelectric cell until the entire spectrum has been covered, while the photographic film is moved through a corresponding distance. Co-ordinate lines and an identification number are printed on the film in a separate compartment of the machine.

The entire operation of analyzing a color is thus automatic and a complete record of a colored sample can be obtained in less than ten seconds.

"The scientific specification of the color of an object requires the knowledge of the ratio of the amount of light of a definite color reflected from the sample under test to the amount of light of the same color reflected from a standard white substance, such as magnesium carbonate, when illuminated by the same light," Dr. Bazzoni explained in describing the new apparatus.

"Furthermore, this ratio, known as the 'reflection factor,'" must be known for all the colors of the visible spectrum from the violet to the red. By adjusting the 'color analyzer' to read unity for all colors when the standard white sample is tested on it the reflection factors at the various colors will be obtained directly when the sample is tested on the machine at the same adjustment.

"The usual method for obtaining this information at the present time is to find the reflection factors, point by point, throughout the spectrum, depending upon the eye to decide when a brightness match between the sample and the standard white has been obtained at a given color.

"Such a procedure is not only tedious and slow, but the results obtained always depend on the skill and visual acuity of the observer. In addition, the human eye is very insensitive at the ends of the spectrum, in the far violet and in the deep red, and brightness matches at these regions are nearly impossible. The new machine has equal sensitivity throughout the entire visible spectrum and can be extended easily into the ultra-violet.

"Since the sample is illuminated obliquely and the light tested is reflected perpendicularly, the effect of any gloss on the surface of the sample is eliminated. By a slight modification of the illuminating unit the machine can be used to measure the gloss of a surface.

"The machine is expected to find wide application in the dye and textile industries, both for the control and uniform reproduction of colors and for maintaining accurate color standards. With a permanent graphical record such as that made in this 'color analyzer' it is possible to match a color perfectly without ever seeing the actual color.

"Because color specifications can be obtained so quickly with it, the machine is especially suitable for the study of colors which change rapidly, such as certain biological pigments. It already has been used successfully to study color changes in samples of blood.

"It has been found possible, by use of the apparatus, to differentiate between two colored samples known to be of different compositions but which appeared exactly alike to the eye, while recently the machine also was found to be suitable for the study of the fading of colors in materials by showing definitely which portions of the spectrum were most readily affected.

"Another group of tests was made on samples of gasoline in which differences from the so-called 'water-white' were detected which could not have been seen by the eye. The apparatus also has been used to measure the difference in the 'whiteness' of samples of paper."

Mr. Mulder, who formerly lived in Holland, Mich., holds the degree of bachelor of science from Hope College and the degree of master of science from the University of Michigan. He was an instructor in physics at Swarthmore College for a brief period before coming to the University of Pennsylvania.

Mr. Razek was graduated in mechanical engineering from Washington University in St. Louis, and was instructor in that subject at the University of Pennsylvania prior to entering the Department of Physics.

David Joins Sandoz

Friends of Sidney R. David, long head of S. R. David & Co., Inc., 252 Congress Street, Boston, will be interested to know that as of February 1 he became New England manager for the Sandoz Chemical Works.

Mr. David has had a lifetime of experience in the dyestuff field. When the war broke out he was with the Bayer Company, but soon went with William Beckers when he opened his plant in Brooklyn. When the Beckers interests joined the Schoellkopfs to form the National Aniline & Chemical Company, he became an officer of this concern and remained with them until going into business for himself in Boston as S. R. David & Co.

His host of friends will wish him well in his new connection.

Technical Notes from Foreign Sources

Arylido-Anthraquinone Derivatives

German Patent No. 435,748; *I. G. Farbenindustrie A.-G.*—By heating 5-8-dichlor-quinizarine with aniline in presence of copper powder and potassium carbonate, the dianilido compound is formed; characters, m. p. 245° C., sol. in conc. sulphuric acid with red-violet, in alkalies with blue color. In this patent the product obtained in a similar way, but with omission of the copper powder, has a m. p. of 258 to 260° C., dissolves in conc. sulphuric acid with a green color, and is insoluble in caustic alkali. Yields are fairly good—about 80%; the product is homogeneous and is ready at once for conversion, in the ways usual in this group, into dyestuffs.

Study of the Saponification of Acetyl Cellulose

D. Krueger; Mell. Textil-Ber. 10, 208 (1929).—A study of the speed of the saponification reaction of cellulose acetate through methyl alcoholic potash. A purely chemical paper of no obvious reference to practical aspects so far as they are at present known. Two graphs and five tables are included.

Recent Studies Regarding the Theory of Acetate-Silk Dyeing

H. Brandenburger; Mell. Textil-Ber. 10, 215 (1929).—Another paper from the physico-chemical side of the subject. Includes five tables and two graphs. The study is being continued.

Simultaneous Uniform Dyeing of Viscose and Cotton in Mixed Weaves

Dr. A. Landolt; Mell. Textil-Ber. 10, 214 (1929).—One of the most difficult tasks, which involves not merely bringing the cotton to the same depth of dyeing as the viscose, but to the same tone also. There is also a further complication, the possible streakiness of the dyed viscose. The dyer has to consider these points carefully before beginning work. While dyeing of the two fibers to the same depth of tone is generally possible for light tones, this is not usually the case with medium to deep tones; the greater affinity of the viscose for dyestuffs makes itself more or less strongly evident; the viscose is dyed more deeply than the cotton; a serious objection in the case of certain weaves, where the lightly dyed cotton back shows through the more deeply dyed viscose face.

Since the different dyestuffs behave differently in their relative affinity for viscose, it should be possible to classify them as has already been done in reference to the question of avoiding streakily dyed viscose alone. The Gesellschaft fuer Chemische Industrie, of Basle, has published a list of those dyestuffs which come into consideration particularly for this simultaneous dyeing, in uniform tone, of the cotton-viscose mixtures. The list is as follows:

(a) Direct Dyestuffs—Direct Yellow 5G Conc.*, Cotton Yellow CH*, Direct Fast Orange WS*, SE*, Direct Catechin GG*, B*, GR*, Cupranil Brown R*, B*, Direct Brown GN*, 5G*, Direct Fast Bordeaux G, Direct Fast Scarlet G*, B*, 3B*, SE*, R*, 10BS, Direct Scarlet 3BS, BS*, Direct Pink BN, 3BN, GN, Direct Safranine RW, Direct Brilliant Pink B, 3B, Chlorantine Lilac B, Direct Fast Violet 6BL, Melantherine BH, HW, GS, Cotton Blue N, Direct Brilliant Blue 6BR, 8B*, Direct Dark Green S, Artificial Silk Black GN, GE, Cotton Red 4B*, D*, Carbide Fulling Black PLS Conc.*, R Conc.*

(b) Chlorantine Light Dyestuffs—Direct Fast Yellow FF*, B*, Chlorantine Light Yellow 4GL*, RL*, Chlorantine Light Orange G*, TGL, TRL*, 2RL*, T3RL, Chlorantine Light Brown RL, 3RL, BRL, Chlorantine Light Red 5BL*, 7BL*, Chlorantine Light Rubine RL*, Chlorantine Light Violet RL*, BLN, 5BL*, 4BLN, Chlorantine Light Blue GLN, 4GL, 8GL*, BL, Chlorantine Light Gray BLN, GLN, RLN, BLL, RLL, Chlorantine Black L*.

Note—Dyes starred (*) dye uniformly even in very deep tones.

By choosing suitable dyestuffs the problem is not entirely solved, for any choice excludes a number of other valuable products. However, with this grouping of the dyestuffs we have exhausted only one possibility. Another such lies in the modification of the fibers themselves, the viscose or the cotton, modification of their affinity for dyestuffs, in such a way that compensation takes place. Such a modification can be attained, for example, through mercerization, or by treatment of the mixed goods with caustic liquor of varying concentrations. But since viscose swells strongly in only reasonably strong caustic, the practical carrying out of this possibility is involved in considerable difficulty. There is a whole series of patents, in which procedures are described for protecting the viscose when mixed weaves are mercerized. Thus, for enample, according to English Patent No. 230,187, the viscose is treated, before weaving, with gelatine or gelatine alumin-

ium acetate; according to English Patent No. 295,062, by washing of the fabric, after mercerization, with water of from 70° to 100° C. damage to the viscose is obviated, while English Patent No. 295,488 recommends mercerization with caustic potash. American Patents Nos. 1,343,138 and 1,344,139 recommend an addition of phenol or formaldehyde to the caustic soda, Patents Nos. 1,348,802 and 1,346,803 an addition of glycerol or monacetine. Finally, American Patent No. 1,392,833 prescribes saturation of the caustic soda liquor with potassium acetate. The treatment with caustic soda, however, apart from technical difficulties, involves certain disadvantages, the first of which is the rendering of the whole finishing process more expensive. Besides, effects result from the mercerization which are not in all cases desirable.

A final possibility, that of modifying the affinity of viscose or cotton for the dyestuff, lies in the alteration of the conditions during the dyeing process. We know that when dyeing with direct cotton colors at a low temperature and with little salt, uniform dyeings are gotten more easily than at a higher temperature and with a higher percentage of salt. We dye best with addition of 5 to 10% of Glauber salt, bath 1-30, entering at 30° and going slowly to 50 to 60°. In this way, however, we attain deep dyeings only by use of large amounts of dyestuff. Now if the affinity of the mixed weave for dyestuff at the higher temperature be altered in favor of the viscose, it must follow that the viscose will have a greater affinity for the highly dispersed phase than the cotton, since even in dyestuff solutions an increase in the degree of dispersion goes hand in hand with a rise in temperature. If it were possible to decrease the degree of dispersion at the higher temperature, the affinity for dyestuff would be altered in favor of the cotton. This can be proved by experiment. If one increases the amount of salt in solution in the dye bath to an abnormal degree, that is, until the dyestuff is nearly salted out, many dyestuffs take more strongly upon the cotton than under normal conditions, while the viscose remains lighter in shade, so that compensation is possible in this way. We dye, for example, as follows: The dye bath is made up with 150 g. of Glauber salt cryst. per liter. At 40° C. the dyestuff is added in solution, the goods are entered, and dyed with gradual heating up to 80° C. The dye bath is almost completely exhausted, so that it can be used again by adding the proper amount of dyestuff. Whether this method of dyeing, which is theoretically very interesting, has also any practical valve, is not yet certain. It has at least been proved that according to this method a simultaneous uniform dyeing of dark marine blue and brown tones, which up to now has been very difficult, is possible.

It should also be mentioned that the problem of this simultaneous dyeing could naturally be solved most fundamentally, if it were possible to produce a viscose with a lower affinity for dyestuffs. Cf. Mell. Textil-Ber. 9, 684 (1928).

Dyeing of Artificial Silk Alone and in Mixed Weaves

Dr. H. Hoz; Mell. Textil-Ber. 10, 206 (1929).—In an earlier publication in another place (Leipziger Monats-Schr. f. Textil-Ind. Fach-Heft 1, 1928; S. 35, and Zeitsch. f. d. Gesamt. Textil-Ind. S. 589, 1928), the frequent occurrence of unevenness in dyed artificial silk was spoken of, and an effort was made to show how this trouble might possibly be avoided. Briefly summarized, the purpose of these articles was as follows: In spite of correct and most carefully followed working conditions, it continually happens that with artificial silks the dyeings come out uneven, a result which is always plausibly laid to the dyeing. Scientific investigation, however, has shown that this result is not to be ascribed to the dyeing (presupposing, of course, that the dyeing was properly carried out), but that it originates in the nature of the artificial silk itself. The manufacture of artificial silk is a so extraordinarily complicated colloid chemical process that it is simply not possible to regulate the whole process of manufacture in an unvarying manner. The ripening process, the alkali cellulose, the conditions in the precipitating bath at the time of precipitation, and a whole series of other critical points, as well as atmospheric conditions, etc., bring about slight alterations in the nature of the artificial silk fibers, which in their turn occasion a varying affinity of the fiber for the dyestuffs to be used. Furthermore, the condition of the surface and of the internal structure (position of the micelles) play an important part in the question of the affinity toward dyestuffs. In course of time, through continuous countless investigations, it has become plain that not all dyestuffs are equally sensitive toward these inequalities, so that there has been nothing else to do but to look for the dyestuffs least sensitive in this connection. This search has been directed first of all among the direct dyestuffs, so much used for artificial silk. The most different methods of testing them have been proposed, but in practice have yielded mostly unsatisfactory results. The author has succeeded in obtaining two lots of viscose, of which one dyed much lighter than the other; fabrics were woven of these two grades in different patterns, and swatches of these dyed (and used to illustrate the original article). On this material was tried a great number of direct dyestuffs in the endeavor to find what dyestuffs were insensitive in the way under investigation, and it was found that, in spite of many statements to the contrary, dyeing must be carried out for at least a short time at the boil; for at least one-half hour; and that this is essential.

Now, Diphenyl Pure Blue FF, Chicago Blue 6B, Diamine Pure Blue FF, and Benzo Light Blue 4GL, Diphenyl Fast Blue 4GL, etc., very easily give unequal dyeings, and can serve as reagents for artificial silks which dye unevenly. Unfortunately, there are among the blue direct dyestuffs none which are wholly insensi-

tive toward the different grades of viscose. There are, however, a few which give better results than the above-mentioned blues. Of the whole series examined, the useful dyestuffs selected in this way were divided into two groups, one of the "very good," which gave practically no difference in tone upon the test goods, and the other "good," which did show some visible difference between the two grades of viscose in the test dyeing, but could give usable dyeings, particularly when it is considered that the woven material used for the tests shows so great a difference in affinity in its two elements as would hardly ever occur in practical work. The dyestuffs thus classified are:

"Very Good"—Diphenyl Pure Yellow 5G*, Diphenyl Chrysoin 3G* (Chrysophenine), Diphenyl Fast Yellow C4GL*, GL*, 4GL*, Diphenyl Citronine GE*, Diphenyl Chlorine Yellow FF*, Diphenyl Fast Orange GG*, SE*, Diphenyl Orange GG, Direct Pink EB*, 3BN*, Diphenyl Red BS, Diphenyl Fast Red 7BL*, 5BL*, Direct Violet RE*, Cotton Brilliant Flue 8B* (not fast to water), all the Direct Blacks (for deep black), Diazo Phenyl Black D* (for gray and deep black).

"Good"—Diphenyl Yellow CGS*, Diphenyl Chlorine Yellow B, BR, Diphenyl Fast Yellow RL, Direct Orange RF, Polyphenyl Orange SP, Diphenyl Brown GRI, GS, BBN, Diphenyl Fast Scarlet RS*, Diphenyl Fast Red B*, Diphenyl Fast Bordeaux G, Diphenyl Violet TS, JZ, 2R, Diphenyl Blue 2B, Diphenyl Fast Blue BL, 2GLN, Diphenyl Dark Blue R, Diphenyl Green KGC, KGI*, Diphenyl Fast Gray BS*, Diphenyl Fast Black L* (for gray).

Note.—Dyes starred (*) dye cotton the same as viscose, in mixed weaves.

In carrying out this study further, with the co-operation of E. Bauder, the author has practically confirmed the observation of Whittaker (Leipziger Monatsschr. f. Textil-Ind. ser. 1928, S. 266) that those dyestuffs least sensitive toward unevenly dyeing viscose are those which show greatest affinity at from 60 to 70° C., or which dye darker at that temperature than in the cold, at 45° C., or at the boil; while those dyestuffs which give the deepest dyeings at the boil give very uneven dyeings upon unevenly dyeing viscose; so that in this way a dyer can secure preliminary information for his needs, even though he has available no samples of unevenly dyeing viscose for actual testing with a given dyestuff. The author believes the reason for the need of dyeing at the boil to be that the dyeings are uneven, anyhow, but that during the boiling the "excess" of dyestuff (the amount which makes the darker spots darker) dissolves off. The norm would apparently be the lightest part of the uneven dyeing.

It was further ascertained that it is not a matter of indifference as to what dyestuffs are used for combinations, even the dyestuffs classified as "very good," as the degree of dispersion prevailing in a given combination in solution may be quite improper for getting the desired results under the conditions to be used. There are a few dyestuffs, namely, Diphenyl Fast Black L, Diphenyl Fast Red 5BL, and Diphenyl Chlorine Yellow FF, with which the other dyestuffs above mentioned can be safely used in any combination, and the dyeings possess very good fastness to light. Beside Diphenyl Fast Yellow FF, the brands C4GL or 5GL are well suited for combinations.

For mixed weaves consisting of cotton and viscose, especially for ladies' stockings, the above dyestuffs are very good; in especial, in combination for mode tones, the following give fast-to-light dyeings: Diphenyl Fast Yellow C4GL, 4GL, Diphenyl Fast Red 5BL, 7BL, Diphenyl Fast Brown BRL, Diphenyl Fast Blue 2GLN, Diphenyl Fast Gray BS, Diphenyl Fast Black L, Diphenyl Fast Orange EG, ER, Diphenyl Fast Rubine RL, Diphenyl Fast Violet C2R, Diphenyl Fast Green B. They are best dyed as follows: Enter at 40 to 50° C., for light tones without Glauber salt, for dark tones with addition of the necessary amount of Glauber salt; raise slowly to 60° C., dye for one-quarter hour at this temperature, then raise to the boil and dye for 10 minutes in boiling bath. In this way the stitches in hosiery are dyed through perfectly. In mixed weaves of cotton and Bemberg silk, which appear to be coming more and more into favor, the dyeing is carried out a little differently. First of all, it should be emphasized that mercerized cotton only must be used in such goods, if uniform tones are to be gotten, for the affinity of Bemberg silk for dyestuffs is far greater than is the case with cotton, and the Bemberg silk almost drags the dyestuff out of solution, so to speak, to the disadvantage of the cotton. The best results are obtained if the goods are entered into a bath without any salt addition at all, at 90 to 95° C., dyed at that temperature for a short time, the bath then raised to the boil, and the goods dyed at the boil for 20 minutes. The dyestuffs already mentioned give good results; for combinations, Diphenyl Fast Blue 2GLN, Diphenyl Fast Brown BRL, Diphenyl Chlorine Yellow FF, and Diphenyl Fast Black L are best suited. In the case of mixed weaves of cotton and viscose, when it is desired to dye the viscose in lighter tones than the cotton, the following dyestuffs: Diphenyl Chlorine Yellow FF, Diphenyl Chrysoin 3G, Diphenyl Fast Orange C, Diphenyl Catechin G, Polyphenyl Blue G, Diphenyl Fast Brown 3GL, Polyphenyl Yellow R, Polyphenyl Orange R, Diphenyl Fast Brown GN, Direct Pink EB, and Diphenyl Blue Black will give such dyeings. The dye bath is prepared with the necessary amount of dyestuff, the goods entered cold without any addition, and dyed for a short time cold, the temperature then raised during 20 minutes to 40° C., from 10 to 20% of Glauber salt, according to the depth of tone desired, then added, and the goods dyed at this temperature for three-quarter hour. Through more or less strong heating of the bath, it is possible to force more or less of the dyestuff upon the viscose.

No More "Guesstimating" in the Modern Chemical Plant

The trend in the modern chemical plant is to meter everything of importance that can be metered.

Not so many years ago, probably within the memory of every reader, there was scarcely a meter in any chemical plant aside from the water meter, and possible the gas meter.

Even the electric meter is old as compared with economizing meters that have been developed in the last very few years.

Water, gas and electric meters were designed and installed solely for the purpose of "selling" water, gas and electricity to a customer. They involved no thought of economy between the seller and consumer.

To install a private meter for measuring one's own steam consumption, or coal consumption, simply for the sake of *knowing* what was going on was considered as ridiculous as the installation of a cash register by a butcher who was himself the sole owner, dealer, helper, and janitor of the establishment. To-day it is considered quite the thing for nearly every store, regardless of smallness or largeness, to have a cash register.

And similarly it has been found that it pays to *know* all about the steam, the CO_2, the draft, the temperatures, and the coal in one's own establishment regardless, almost of size.

The *old* method was to operate a plant by sheer force and wealth. There was very little check on anything. The owner or manager simply "guesstimated." If more coal was needed it was ordered, paid for, and burned. The burning of a thousand tons of coal more one year than another was considered a sort of "act of God"—a mysterious condition that had to be tolerated.

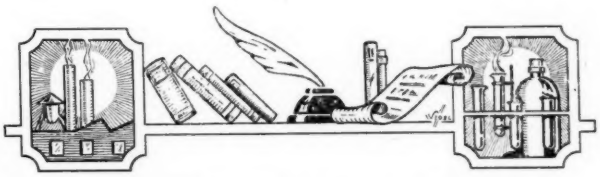
To-day things are decidedly different. An accurate steam meter may be placed on the switchboard any distance from the boilers. The meter tells the entire story—past and present. There is no more "guesstimating" by the owner, manager, or engineer regarding the amount of steam generated by the boilers and the amounts used in the various departments. Total generation and total consumption are carefully and accurately accounted for.

The pyrometer, on the same switchboard, tells the entire story, past and present, about temperatures in the chimney, in the furnace, of the superheater, or anything else of importance. No more "guesstimating" about temperatures.

Draft, CO_2, and coal are similarly metered, and where desired permanent graphical records are made.

To-day, as soon as any one of the recorders shows that things are "going wrong" it is a simple matter to rectify matters because the engineer can instantly lay his finger on the *cause* of the change in conditions. The result is: not much fuel is saved.

Whether or not it will really *pay* to install a steam flow meter, pyrometer, CO_2 recorder, etc., sometimes requires careful figuring. However, fuels are so expensive, and it has been demonstrated time and again that indicators and recorders can save *much* fuel, that it is indeed a small plant that cannot make recorders *pay* and pay *big*.



RECENT LITERATURE

Organization, Management and Technology in the Manufacture of Men's Clothing. By Martin E. Popkin, Consulting Engineer, formerly Manufacturer and Director of Research, J. Schoeneman, Inc.; Associate, W. L. Churchill, Industrial Economists-Engineers; Director, Manufacturing and Merchandising Counselors; Associate, American Institute of Electrical Engineers; Associate, American Society of Mechanical Engineers. 415 pages. Illustrations, charts and diagrams, 236. Isaac Pitman & Sons, New York and London. Price $10.00.

In the last few years the manufacture of men's clothing has been developing along scientific lines, and as a result much valuable information has been gathered by independent concerns and individual workers. With this development there has arisen an awakening as to greater possibilities and also a keen desire on the part of many young men in the industry to extend their activities beyond the scope of the shopman, clerk and tradesman.

Up to the present time one of the great difficulties has been in securing the necessary information for use and study. This obstacle has been to a very great extent overcome by the publication of this book. The practical experience of the author, combined with his technical training and scientific knowledge, at once opens to such young men an authoritative source of much of the knowledge they require.

The scope of the book is so broad that it furnishes a valuable reference volume for the clothing manufacturer in general.

The text covers every phase of the clothing industry, beginning with the location of the plant and the organization of the personnel, and continuing with a study of the variations in anatomy that must be considered, the textile materials used, importance of style, all stages of the manufacturing process, cost finding, regulation of production, distribution, laboratory control, etc.

The industry will undoubtedly find it to its advantage to give due consideration to this volume. Textile chemists and technologists will be specially interested in the chapter dealing with laboratory control.

L. A. O.

The rate for "Position Wanted" advertisements in this column is 2 cents a word—with a minimum of 50 cents per insertion. For all other types of advertisements—i. e., help wanted, machinery or supplies for sale—the rate is $5.00 per column inch or less per insertion.

POSITION WANTED BY DYER

Young man with experience dyeing Cotton and Rayon Sewing Thread with Naphthol, Indanthrene, Sulphur, Developed, Direct and Basic Dyes. Address: Classified Box No. 579, American Dyestuff Reporter, 440 Fourth Avenue, New York, N. Y.

RAYON SKEIN DYER

Rayon Skein Dyer with 20 years' experience dyeing all kinds of rayon desires position in or near New York City. Address: Classified Box No. 580, American Dyestuff Reporter, 440 Fourth Avenue, New York, N. Y.

PRINT WORKS

Chemist and Color Mixer; age 25; experienced on all classes of colors and fabrics. Textile school graduate; best of references. Reply: Classified Box No. 581, American Dyestuff Reporter, 440 Fourth Avenue, New York, N. Y.

WANTED

Woolen and Worsted yarn dyer in large dyehouse. State full particulars, giving experience, age, salary, nationality, etc. Address: Classified Box No. 582, American Dyestuff Reporter, 440 Fourth Avenue, New York, N. Y.

ASSISTANT SUPERINTENDENT

In the prime of life, yet with eighteen well-filled years of experience, former superintendent of specialty plant producing ribbons, dress and lamp shade trimmings, braids and cords in all fibers, is available for position of Assistant Superintendent or Purchasing Agent in textile or specialty plant. Address: Classified Box No. 583, American Dyestuff Reporter, 440 Fourth Avenue, New York, N. Y.

MY EXPERIENCE

Fourteen years on Wool Piece and Raw Stock dyeing.
Two years on Union material.
One year on job dyeing of tussah, rayon, cotton, Celanese and mixed fibers of all kinds.

I am aggressive naturally, and a producer. I am ready and offer my greatest energy to a real live-wire mill in the capacity of head dyer. My previous employers will be pleased to tell you of my ability and character. Address: Classified Box No. 584, American Dyestuff Reporter, 440 Fourth Avenue, New York, N. Y.

Hercules Powder Co. Shows Increased Profits

Showing a substantial gain in receipts and net profits and maintaining a strong financial position, the Hercules Powder Company continued to expand both its domestic and export business last year, according to the company's annual report just issued.

Increased efficiency in manufacturing processes and new technical developments widening the company's markets were a feature of the business year, according to R. H. Dunham, president.

Units at Gillespie, N. J., and Bessemer, Ala., for the manufacture of nitric acid by the oxidation of ammonia were completed during the year, and substantial additions and improvements gave increased capacity to the company's cotton linters and nitro-cellulose plants. Expenditures for research and development were increased during the year, and plans were completed to add further effectiveness to these lines by moving the central experimental station to a site recently purchased near Wilmington, Del.

The Ciba Company, Inc., announce the removal of their Atlanta, Ga., office to Greenville, S. C. The new address is the Chamber of Commerce Building, Greenville, S. C. The new telephone is Greenville 50.

This branch will be in charge of John C. Crosby, and will be under the supervision of the Ciba Southern manager, R. W. Glenn.

A laboratory will be maintained in Greenville, together with a warehouse carrying a full supply of the famous Ciba dyestuffs.

At a meeting of the board of directors of The Permutit Company held December 30, H. Kriegsheim, who had been president of the company for the past seven years, was appointed chairman of the board, and W. Spencer Robertson, formerly secretary of the American Locomotive Company, was appointed president of the company.

Mr. Kriegsheim will continue to take an active interest in the management of the company.

On January 1, 1930, the Atlas Electric Devices Company moved from their present location into larger quarters before the expiration of their present ten-year lease in order to take care of the great demand for testing quipment. They now occupy the entire second floor of the Huron and Orleans Building "B," 361 West Superior Street, Chicago, Ill.